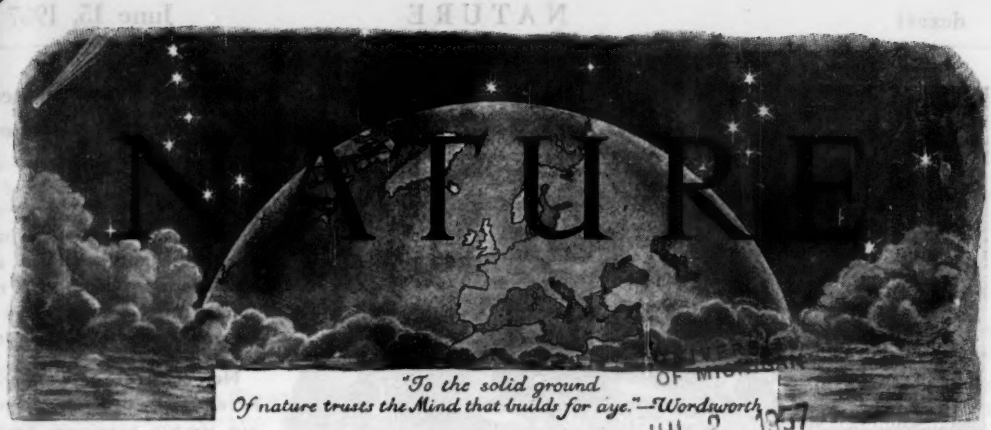

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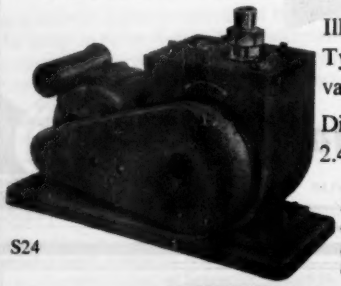

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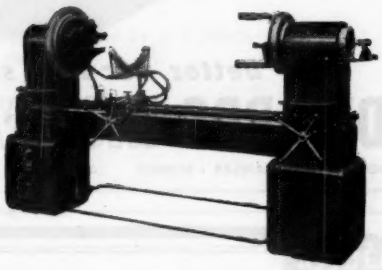

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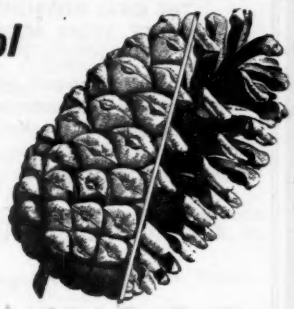

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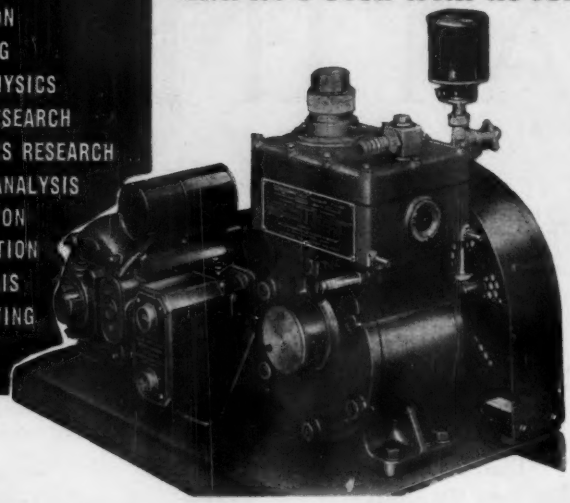

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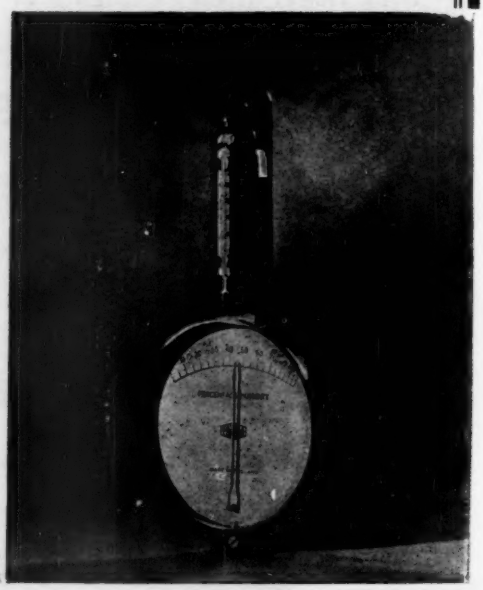

NATURE

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SECRECY, SECURITY AND FREEDOM

ADDRESSING a study group of the Committee on Science and Freedom in Paris on "Freedom and Responsibility in Academic Life", Prof. C. D. Darlington said that the voice of the new learning, of science, is desperately needed in Britain for three main reasons: first, because of the separation of science from politics at the foundation of the Royal Society; second, because of the pace of scientific change, arising largely from specialized activities connected with the Royal Society; and third, because of the widening gulf left by university education between the scientist and the non-scientist, a misfortune for which both are to blame. Prof. Darlington began by pointing out the necessity for science to express its needs to the State through its own representatives; only by breaking down the separation of science from the ordinary life, thoughts and discussions of society can the freedom of science now be preserved, and in this *rapprochement* he thought the Royal Society and other learned societies and the universities have the most important contribution to make. The learned bodies, he maintained, must devote some of their time and interest to the problems of the societies in which they live, and, comparing the two opposed systems of university administration in Britain and Germany, he suggested that complete autonomy has its own dangers. Lay interference, when exercised to a limited extent at rare intervals and by responsible authorities and organizations understanding the university tradition, has its advantages, and can avoid the incompetence and stagnation that sometimes attend self-determination. There must always be the means of interaction between the scholar or scientist and the layman if the community is to be healthy, and this demands both the education of the public in regard to learning and the education of the learned world in regard to the public.

Both these are the duties of the universities; but at the present time, said Prof. Darlington, nowhere in the world do the universities give their students any notion of the state of human knowledge as a whole and as it is to-day. While he was concerned more especially with the British scene, there is much to support his argument in Prof. E. A. Shils's recent study of the background and consequences of American security problems*. Prof. Shils makes it clear how, largely in a different setting, the lack of understanding between the scientist and scholar and the ordinary citizen contributed to permit the development of policies which have done so much harm to science.

Perhaps that aspect is displayed even more clearly in an article "Secrecy and Scientific Progress", based on a statement by Dr. L. V. Berkner to the Government Information Sub-committee of the Committee on Government Operations, House of Representatives, in March 1956, which has since been published in *Science*. In that article Dr. Berkner gives an outstanding analysis of the dangers attending technological secrecy, which is as valid for Britain as for the United States, and he indicates precisely the factors involved in achieving the best balance between secrecy and free information. Like Prof. Shils, he recognizes the inevitability of some secrecy, but he also emphasizes the limits to such secrecy if security is to be effective. As more and more scientific activity tends to come within the purview of secrecy regulations, it is imperative that these limits shall be clearly understood, and an authoritative appraisal of the effects of secrecy on scientific strength and progress in Britain, and therefore on national security, is to be welcomed.

We cannot afford to burden a security system with secrets which need not be kept, and both Dr. Berkner and Prof. Shils are concerned to point the way to improvements in security policy, either through technical and administrative changes, better training of those responsible for the execution of security policy or the improvement of the environment in which the necessary policy is conducted. The fact that the environment in Britain is much healthier than in the United States does not diminish the value of a number of suggestions which are made by Dr. Berkner and by Prof. Shils. Not the least of their service is that they should stimulate constructive thinking about a real and continuing danger to science.

Dr. Berkner points out that in suppressing seemingly isolated pieces of scientific information of direct military value, we hinder, if not prevent, at the same time, the germination of scientific ideas of much greater scientific, social and military significance. He rightly observes that injection into our industrial complex of the great concepts generated from a free and virile science provides far greater security through technological supremacy than can ever be achieved by classifying technological information. Moreover, technological secrecy is something quite different from the secrecy of tactics and battle order, of communication codes, of intelligence and of citations, if only because the inexorable march of science inevitably opens it in due course to the enemy unless he himself discards science. The secrets of Nature cannot be denied to a nation with scientists and a scientific tradition.

One effect of the present security procedures which Prof. Shils does not discuss is strongly emphasized by Dr. Berkner, and it may well operate even in Britain. They incline the scientist to avoid contact with any idea that may lead to military application. If the scientist knows no such secrets, he cannot be

* The Torment of Secrecy: The Background and Consequences of American Security Policies. By Prof. Edward A. Shils. Pp. 238. (London: William Heinemann, Ltd., 1956.) 15*s.* net.

involved in security questions and is consequently free from the risk of his reputation being destroyed by any person who makes irresponsible charges. That risk is much slighter in Great Britain than in the United States; but even so, scientists are naturally reluctant to endanger their reputation. Moreover, especially in the United States, clearance is not a permanent status. It is not simply that, once admitted to secret information or having originated such information, a scientist is under continual risk of further clearance review; the threat of such a review may be used for discouraging his exploration of alternative lines of work, if those alternatives do not coincide with current policy.

All this is well illustrated by the Oppenheimer case, as is the embarrassment in which scientists are frequently placed by security questioning relative to their colleagues. More serious, a scientist may well become inadvertently involved in security procedures, because some idea of military importance emerged in discussions with other scientists on topics quite unrelated to defence. There is the further risk that a scientist may express a strong view on some technical matter that may be contrary to current or subsequent policy; and it is not always possible for a scientist to be sure what is, and what is not, secret information.

It is the aggregation of such situations that may condition the scientist not to do the very things most needed both to ensure maximum efficiency in defence policy and the technological and economic strength of the country. Security in practice, if not in policy also, thus alienates the spontaneous will and opportunity of the scientists to contribute to the nation's strength when they possess special knowledge and the vision to see how it can be applied. Responsible men will not consciously allow this to obstruct them in carrying out their duty; the danger is rather that the younger—and creative—scientist may be discouraged and disheartened, so that he feels it is useless to make the effort.

Dr. Berkner notes also, but does not enlarge on, the importance of dissent, on which H. S. Commager was so stimulating in this same context three years ago; though he remarks that technological secrecy tends to obscure the dependence of democracy on diversity of thought and opinion. That alone would make it wise, if not imperative, to limit technological secrecy as much as possible, even if there were not the further risk that clearance procedure may go beyond the protection of secrets; indeed, Dr. Berkner thinks it has already placed some of the best thinkers in the United States behind a wall across which they have no communication with the Government. Moreover, by sharply limiting the number of secret projects, we avoid the risk, inherent in a widespread secrecy system, of defeating the essential secrecy. Accordingly, by limiting secrecy to a few critically important technological matters and enforcing it rigidly and at every step, we serve secrecy itself where essential and minimize the dangers elsewhere to which Dr. Berkner and Prof. Shils direct attention.

This is perhaps the most important principle which Dr. Berkner enunciates, and he adds that technological secrecy should never be used where there is doubt whether its effectiveness will be complete.

Dr. Berkner points out that it is futile in a democratic system to cloak large undertakings in secrecy and also that technological secrecy is lost with the passage of time. His first principle would accordingly involve their declassification after a year or two quite apart from consideration of the technological advantage which could accrue from doing so. It would likewise preclude the attempt to classify basic scientific and engineering information, even if the flow of information on which progress depends were not thereby stopped. Indeed, Dr. Berkner suggests that the security of progress should be the prime objective in a secrecy system.

This principle itself involves as corollaries several others which he puts forward. Without freedom of knowledge, we cannot easily develop alternative choices and select the best. Equally, it is incompatible with the public policy function of a democracy to hinder informed discussion and constructive criticism, as we in Britain have become aware, particularly in the discussion of the developments of nuclear power. Indeed, the bearing of the principles Dr. Berkner enunciates on the development of nuclear energy is obvious, and it could be argued that sufficient secrecy exists in this field both to inhibit such discussion and also to keep the public ignorant of adjustments which must be made in the face of advances.

Dr. Berkner concludes that a deep and searching inquiry into the restrictions on technological information is needed to determine where the public interest really lies. He believes that such an inquiry would define the kinds of technological information that should be kept secret and outlines procedures for its selection and protection; he thinks it would also facilitate a balance of the relevant factors in the national interest. He puts many of the essential questions, some of which, but by no means all, require answering in a British context, and his statement is one to be pondered by all who realize the dangers to scientific advance inherent in secrecy.

That is only one facet of the problem, however, and though Prof. Shils has some wise words on this too, his book, by and large, is concerned with the wider implications in society as a whole. He argues for more reasonableness and common sense, more of a sense of affinity throughout public life, less eagerness to magnify differences and to seek false allies at the extremes. There is perhaps less extremeness and hysteria in this respect in public life in Great Britain than in the United States; but it is none the less true that when the secrecy issue is forced to the front, whether in respect of a tutor's relations with one of his students and a potential employer, in the Civil Service, or in relation to migration and travel, on which several questions have recently been asked in Parliament, reasonableness, common sense, and less disposition to magnify differences are none the less what are wanted here.

As regards science, Prof. Shils underlines several of the points made by Dr. Berkner: the importance of free discussion and contact with new ideas and the element of accidental and unpredictable discovery, the danger of compartmentalizing science and making the scientific career both less attractive to able minds and less conducive to creative work. His book may be of less direct interest to the scientist than Dr. Berkner's statement, but the points he makes need weighing not only in the context of nuclear power developments but also wherever questions of secrecy arise. Moreover, in considering the future of a plural and democratic society, he urges, in words that recall Prof. Darlington's address, the importance not simply of individuals but of groups in the defence of freedom, provided that, for effective co-operation, the judgment of the representatives of science must be mutually acknowledged. The balance between secrecy and security, between order and freedom, can only be achieved when the professional bodies and learned societies, as well as institutions like the universities, bring to that task the great traditions they have inherited and also open minds and the vision and capacity for constructive thought in which they have been trained.

SPECTROSCOPY AND THE ORGANIC CHEMIST

Chemical Applications of Spectroscopy

Edited by W. West. (Technique of Organic Chemistry, Vol. 9.) Pp. xxiv+787. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1956.) 15 dollars.

IN an apocryphal story the late Prof. W. H. Perkin is said to have remarked to a research pupil who murmured something about the Phase Rule, "My dear fellow, physical chemistry doesn't apply to organic compounds". By this he presumably meant that the early attempts to solve problems of molecular structure by additivity rules of molecular volumes, magnetic rotations, etc., had caused nothing but confusion in the very examples where help was needed. That the present-day organic chemist needs physical chemistry, and in a big way, is shown by the appearance of these volumes on technique, now approaching the 10,000-page mark. How he is to find time from synthetic studies to assimilate the matter there described is left to him; Perkin might well have acknowledged the receipt of a volume by saying that he would lose no time in reading it. The position has now been reached where collaboration between experts is essential, and the physical chemists may seem to be appropriating more than their fair share. The classical art of organic chemistry, consisting in the skilful use of synthesis and chemical reactivities to determine molecular structure, is being displaced by X-ray analysis, spectral studies, and even by theoretical calculation.

Vol. 9 is a self-contained treatise on spectroscopy and its use in solving chemical problems, excluding descriptions of instruments and the modes of handling them. It is written very clearly by a team of experts in each of the individual parts of the subject. The introductory survey covers the basal concepts of atomic and molecular energy levels, selection rules, potential energy curves, spin and classification of states of symmetry, together with the elements of the treatment of molecular orbitals by the principles of wave-mechanics. This forms a well-balanced account for the undergraduate student.

A full account of microwave and radio-frequency spectroscopy is presented, a subject so new that the oldest reference given relates to 1948. Here novel applications are rapidly being developed, and the chapter provides an up-to-date account of the theory and its uses in detecting free radicals, in analysis, in following chemical reactions, for studying paramagnetic molecules such as hæmoglobin, and for irradiated amino-acids and protein molecules.

Infra-red and Raman spectra are treated together, first in a chapter on group-theory, symmetry, and selection rules applicable to top-like and asymmetrical top molecules, and secondly in one describing the more empirical extensions of these concepts to complex organic molecules. An account is given of methods of plotting such spectra, of the avoidance of experimental errors, and of the measurement of absolute intensities, and this is followed by a full discussion of group frequencies with examples of their use in structure determination. Other subjects described are cells, temperature effects, appropriate solvents and polarization effects, presented in a form which can be directly comprehended by the organic chemist. This chapter is the one from which the practical worker needing to characterize his new compounds will derive the most likely means of answering his problems.

Electronic molecular spectra are described first in a theoretical section, excellent in itself but unlikely to be understood by an organic chemist, and then by detailed examples of recent attempts to apply theoretical ideas to the ultra-violet spectra of conjugated molecules. This subject is necessarily one of great difficulty, and progress is slow but steady. The account is of value in bringing together recent lines of development, and providing full references for those who wish to venture further into this field; but the field is one for the bold and competent mathematical chemist, and not for the empiricist.

In a final chapter an account is given of fluorescence and phosphorescence spectra of organic compounds, describing all the main features of the subject, such as mean lives, mirror image relationships of spectra, effect of *p*H, effects of molecular structure, quantum yields of fluorescence, and the influence of molecular rigidity. Of particular importance at the present time is the account given of the triplet state of organic molecules and the spectra associated with it. Here the organic chemist will find information gathered together from rather scattered sources and the general principles very clearly explained; one misses, however, any reference to the 'flash' technique recently developed in England, and although not strictly in the spectral field, any hint of the part played by triplet states in photochemical reactions.

No effort has been spared in this book to achieve clarity in explaining basal concepts; repetition is preferred to the obscurity of too great condensation. Each part is excellent, standing rather too completely on its own feet. An over-all picture of the whole subject, explaining to the organic chemist just what can be done by each kind of investigation, and where he can best use the methods in his own work, would be a valuable addition. E. J. BOWEN

PROBABILITY AND SCIENTIFIC INFERENCE

Scientific Inference

By Sir Harold Jeffreys. Second edition. Pp. viii+236. (Cambridge: At the University Press, 1957.) 25*s*. net.

THE first edition of this book was published in 1931. While this second edition has been extensively re-written, the essential principles remain unchanged; as the author puts it in the preface to this new edition: "The general standpoint, that scientific method can be understood if and only if a theory of epistemological probability is provided, remains unaltered". In this theory 'prior probabilities' of scientific hypotheses are continually being modified by the accumulation of fresh evidence. The consequent unity of outlook, coupled with the author's wide knowledge and exposition of physical theory, is in many ways impressive. Nevertheless, many people, whom Jeffreys would rank as (otherwise) reasonably intelligent, think that in this approach he obscures issues just as much as he considers they do. To quote from one recent publication: ". . . scientists, whose successes we all applaud, do not in fact establish their conclusions by inserting values in their equations for initial prior probabilities. The prior probability story is a rigmarole expounded by probability theorists for one another". ("Foundations of Inductive Logic," by Roy Harrod. London: Macmillan, 1956, p. 149.) Again, Prof. Braithwaite in his book "Scientific Explanation" (Cambridge University Press, 1953) rejects Jeffreys's approach in favour of what, to use a rather clumsy phrase, is termed the 'hypothetico-deductive method'.

One bone of contention has been Jeffreys's apparent reluctance to recognize, as others do, statistical probability as a valid concept in its own right. Naturally such an 'intrinsic probability', as Jeffreys calls it on p. 185, can be discussed in terms of his theory, as the latter is all-embracing, but his adoption of the addition rule (which seems to be introduced rather less clearly, on p. 25, than in the first edition or in his book, "The Theory of Probability", where it is more explicitly noted as a convention) makes this easier to do than it would be otherwise. Statistical properties, which are fundamental in many branches of science, are associated with membership of a group or class, the individuals of which are distinct, but the further distinguishing characteristics of which may be ignored: statistical concepts, like many other scientific concepts, are theoretical concepts used as substitutes for actual phenomena. Just as limiting concepts like position and velocity are allowed, so may statistical probability, which is associated with frequency of occurrence. It is by no means clear that this particular concept is most relevant in the domain of quantum phenomena (consider, for example, the problem of identity), and the attempts to combine quantum theory with the theory of probability are still largely formal (the phase-space distribution quoted on p. 219 is real but *not* necessarily positive). However, while presumably Jeffreys's probability theory cannot change, statistical theories have the possibility of extension to cope with new conceptual kinds of average.

Sir Harold's own insistence on the importance of probability theory perhaps justifies its possible over-emphasis in this review. The author will, from previous experience, scarcely expect all his readers to agree with his views, but he is entitled to expect them to consider these carefully. Whether or not one finally accepts his underlying philosophy, his book as much deserves attention now as when it was first written. It contains, moreover, in a comparatively small space, a fascinating wealth of critical commentary and incidental detail on many topics, such as the foundations of mathematics, sampling, dimensions, mensuration, dynamics and relativity. The emergence in science of convenient concepts like electron or length or temperature or (statistical) probability should not mislead us as to what we observe and what we postulate; and Sir Harold's healthy emphasis on the importance of observational evidence is not one that any scientist, least of all a statistician, would cavil at.

M. S. BARTLETT

THE REFUGEE PROBLEM

European Refugees

1939–52. A Study in Forced Population Movement. By M. J. Proudfoot. Pp. 542. (London: Faber and Faber, 1956.) 52*s*. 6*d*.

THIS book takes up the history of European refugee movements at the point where it was left in Sir John Hope Simpson's study of "The Refugee Problem". It begins with a summary of refugee movements that took place immediately before the War, and then deals with war-time movements—the mass expulsions of populations 'swopped' back and forth by their governments at each major shift in the balance of power, the flight of people before advancing armies and from bombed cities, the desperate attempts to escape starvation and the gas chambers, and the recruitment of workers for the German war machine (recruitment that began as a voluntary influx of free workers and degenerated into slave-raiding expeditions). Next the author describes the plans made by the Allies to cope with the dispersed and homeless they were to encounter in their invasion of Europe, the first tests of these plans in Italy and in France, the mass repatriation of millions in the months following the German collapse, the resettlement of those who refused to be repatriated, and the continuing problems presented by the 'hard core'—many of whom are still living in barracks and public buildings.

The political and administrative history of these movements is traced and documented: the early SHAEF plans, the somewhat unhappy record of UNRRA, the great achievements of the International Refugee Organization, and the continuing work of the United Nations High Commissioner's Office for Refugees—each new organization learning a little from its predecessors, devising fresh expedients to deal with a continually changing situation, and struggling with the apathy of a world that still persists in regarding refugees as a temporary problem.

Mr. Proudfoot's account is laconic, precise and unemotional, even at its dramatic points. See, for example, the story of a group of armed Russian refugees who looted and plundered their way across France until visited by General Dragun, chief Soviet liaison officer in Paris: "He picked out ten Soviet refugees, apparently at random, and shot them himself. After this no more protests were received regarding infractions of discipline by these refugees" (pp. 129–130).

Many of the most tragic and telling points in the narrative are tucked away in footnotes: take, for example, the reference to the killing of Jews "at an average daily rate of 5,000 persons" for the years 1943 and 1944 (p. 321), and the plight of physicians and dentists still among the 'hard core' of unrepatriated refugees—men whom no country would accept, although they "had served their fellows for years in the assembly centres, and some had thereby missed opportunities for resettlement" (pp. 430–31). Where it is impossible to maintain this muted tone Mr. Proudfoot quotes from other authors—when dealing with the conditions found in German extermination camps, or when describing the illegal migrations of Jews bound for Palestine, for example.

The book's brief conclusions deal mainly with administrative problems that arise in schemes for the relief, repatriation and resettlement of refugees. But it will interest many others besides those concerned with such schemes. To what groups and institutions do Europeans give their loyalties, and what happens when loyalty to the State conflicts with other loyalties? What are the factors that contribute to the success of an international authority? What are the crucial differences between military and civil organizations, and on what terms can the two collaborate? On these and other questions this book throws useful light—light which is sometimes all the more revealing for being indirect and unintended.

D. V. Donnison

THEORY AND PRACTICE OF RHEOLOGY

Rheology

Theory and Applications. Edited by F. R. Eirich. Vol. 1. Pp. xiv+761. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1956.) 20 dollars.

IT would seem that this work, of which two further volumes are shortly to appear, is an attempt to unify the theory and much of the practice of rheology. Already quite a large collection of books on rheology is available, including a series of seven International Rheology Monographs; though the latter, with but one exception, do not deal primarily with fundamental theory. The British Society of Rheology has listed, in a recent *Bulletin*, more than fifty books on this still youthful branch of physics, though it must be admitted, again, that many of these are either students' text-books or deal only with very specialized fields.

While it cannot be denied that unification is needed, the tables of contents of these three volumes leave one wondering whether this new work will indeed contribute much to this unification and also whether the later volumes especially may not prove to contain much the same material as that which is already available elsewhere, often written by the same authors. However, the first volume, here under review, is the least subject to this criticism.

Until recent times, when the widespread appearance of 'Weissenberg effects' among industrial materials has directed attention to the need for a tensorial approach, most practical rheologists were content with unidirectional tests, ignoring any components of stress and even of strain and flow, in other planes. Even for *ad hoc* purposes, this attitude is becoming increasingly difficult, and perhaps it is not too much to ask the industrial rheologist of to-day to learn enough tensor theory to follow Prof. Reiner's admirable treatment of "Phenomenological Macrorheology". Whether he can also be expected to master Riemannian geometry is more questionable; perhaps younger readers will feel that an elderly reviewer is over-pessimistic in his doubts on these matters.

It is not possible here to mention all the sixteen essays in this volume. Suffice it to say that leading authorities discuss plasticity and hardening of metals, theory of dislocations, high-pressure rheology, theories of viscosity and of large deformations, problems of visco-elastic behaviour, optical and acoustical methods of testing, as well as many of the rheological properties of high polymers.

The book is admirably produced and printed—as it should be for the price—and I can find only one major misprint: the mis-spelling of Dr. Treloar's name throughout a whole chapter.

While sympathizing with the editor in his task of unifying the work of so many authorities from many lands, one cannot help regretting that he has decided not to attempt any standardization of symbols. It is to be hoped that, in the later volumes, at least the most widely used concepts will have a unified symbolism. If this is quite impossible, at least it should be insisted that the authors' tables of nomenclature at the end of each essay should be complete.

Were this a work of less importance, I would hesitate to make these rather stringent criticisms. But the book is a most important contribution by writers of outstanding authority, nor are the later volumes yet apparently completed. It is therefore hoped that there may be time to give consideration to some of these points before the work is finished. If this can be done, and especially if too much duplication can be avoided, the work will doubtless prove to be a major contribution to rheological literature.

G. W. Scott Blair

GRASS FARMING

Grassland Farming in the Humid Northeast

By Prof. Ford S. Prince. (The Grassland Farm Series.) Pp. xii+441. (Princeton, N.J.: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1956.) 45*s*. net.

Theory and Dynamics of Grassland Agriculture

By Prof. Jack R. Harlan. (The Grassland Farm Series.) Pp. x+281. (Princeton, N.J.: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1956.) 42*s*. net.

THESE two volumes are complementary to each other in the Grassland Farm Series edited by W. A. Wheeler. Both works lay the utmost stress upon the grassland sward as a crop having the dual purpose of providing livestock food and improving the soil. Prof. Ford Prince's book sets out to be intensely practical and to offer detailed guidance to the farmers of the north-eastern region of the United States. Practical day-to-day information is offered on such matters as seeds mixtures, liming and manuring for good grass production, pasture management, grass conservation and grass for use by different classes of

ordinary farm animals. One chapter is devoted to the economics of grassland as a component of the mixed farm.

The important place of the legume in the sward is emphasized, and three chapters are devoted to detailed reviews of lucerne, white clover and other major legumes used in temperate pastures. Grasses are dealt with similarly with the emphasis on *Bromus* [*zerna*] *inermis* and on *Phleum pratense*, both of which are in common use in the northern States. Insects and fungal parts of grassland are treated briefly and the place of the modern herbicide is discussed. The practical application of existing grassland knowledge by the advisory officer and the farmer is treated from the experiences of organization of grassland advisory programmes applicable to North America. The same kind of organization may well have wider application and may suggest techniques which advisory officers in other countries might use.

"Grassland Agriculture" by Prof. J. R. Harlan is more ambitious in scope. The first two-thirds of the book deal with the theory and dynamics of growth and the use of grass by the animal. The first chapter gives an account of the geography of climate in relation to soil and vegetation. Another chapter reviews the ecology of grassland and this is followed by discussions of various grassland formations and of the taxonomic classification of the two major grassland families, namely, Gramineæ and Leguminosæ, with some reference to evolutionary trends within each. The attempt made at correlating taxonomy with distribution, evolution and ecological evaluation may not find general acceptance.

The three chapters dealing with plant physiology, soil and animal nutrition respectively treat with data common to crop and animal in general. Many of the points discussed tend to be over-simplified as, for example, the role and effects of applying lime to soils (p. 146). These chapters, however, offer a sound background to the student reader, since much of the material is basic and the author's approach is a good one. It is well, for example, to point out that less than half the nitrogen applied to crops as in normal farm practice is actually taken up by the plant. It is not enough, however, simply to say that the ". . . rest is usually lost by leaching or other means" (p. 148). The matter is one of immense practical and theoretical importance, and the author might well have expanded the argument. The book is well written and comparatively free from gross errors. However, there is one error that needs correction. One or two ounces of molybdate rather than "1–2 pounds" (p. 150) have sufficed as a corrective on lands deficient in molybdenum in Australia, and it is *ounces* of molybdate per acre that are used in commercial practice to-day throughout Australia and New Zealand where molybdenized superphosphate is employed as a fertilizer.

The last few chapters of Harlan's book have a more practical bias. That dealing with the evaluation of pasture and other forages provides a good review, and is reasonably up to date in a subject where research workers are active in many countries. The essentially ecological approach to the whole theme of grassland is most pleasing, while the attempt to synthesize the evidence from basic researches is to be commended. It is well to recognize that new farming procedures, such as irrigation (the author's example is used), involve not only the simple act of applying water, but may be the start of a completely new eco-system demanding an entirely fresh approach to the use of plant materials as well as to fertilizer and management practices.

Both these books are worthy of any library bookshelf. That by Prof. Ford Prince is well illustrated and is an admirable practical guide of particular value to the thinking farmer and to the advisory officer. Prof. Harlan's book offers a sound approach to the scientific basis of modern grassland thought and can be recommended to the studious reader who seeks some knowledge of basic ecology and an integration of thought upon matters relating to the soil/grass/animal complex.

W. Davies

SOLAR RESEARCH

Ergebnisse und Probleme der Sonnenforschung

Von Dr. M. Waldmeier. Zweite, erweiterte Auflage. Pp. xii+389. (Leipzig: Akademische Verlagsgesellschaft Geest und Portig K.-G., 1955.) 38 D.M.

THE publication of a revised second edition of this work, dealing with the results and problems of modern solar research, is most welcome. Prof. M. Waldmeier, director of the Swiss Astronomical Observatory at Zurich, has spent all his life in intensive solar work and has become a well-known authority in this field. At the time of the first edition, in 1941, no other book of this kind was available, and it was received very well indeed. Owing to the war conditions the first printing tended to remain restricted to central European countries. The new edition, which was already in preparation before the War ended, was delayed for some years owing to the post-war situation in Germany. In spite of all these difficulties the author has been successful in bringing the book up to date so that it really represents the modern position of our knowledge of the Sun.

It presents, systematically arranged, the numerous variable phenomena on the Sun which are nowadays the subject of extensive observational activity all over the world. Besides this, general results and conclusions are dealt with and the theoretical insight gained so far is briefly outlined. Historical, technical and purely theoretical investigations, however, are on the whole avoided. The structure of the book, therefore, essentially depicts the following solar phenomena: radiation and energy-production, rotation, and surface-phenomena (sunspots, faculæ, prominences). Further chapters deal with the interesting and involved problems of the line-spectrum of the Sun, and with the solar corona which is the author's special realm.

The present edition contains two completely new chapters: one deals with the radio-emission of the Sun, the other is a short section on solar–terrestrial relationships. They take into account the enormous advances achieved during the past few years. The book has been thoroughly revised and brought well up to date; in particular, the treatment of the chromospheric eruptions, prominences, corona and magnetic conditions of the Sun is much extended and supplemented by new sections, in accordance with recent progress.

The book is well illustrated and contains numerous useful diagrams, tables and numerical data. The illustrations, too, have been amplified by some excellent pictures of eruptions and prominences. Many readers will be pleased to find a list of the well-known and frequently used sunspot-numbers of the Zurich Observatory giving now monthly means from

1749 onwards. But it is much to be regretted that there is now no index, although one was to be found in the first edition. An index is of great importance in a book of this kind, which is likely to be consulted on various occasions.

The book is extremely useful for every kind of practical work in the field of solar research. But beyond this range it can also be warmly recommended to the much larger group of readers from the various borderlands of solar research. The mathematical and physical knowledge assumed in the reader is to a large extent of an elementary nature, so that the book is also well suited to the amateur and for schools, as well as for instruction at higher levels. Of particular value are the ample and carefully quoted references.

H. VON KLÜBER

THE BIOLOGY OF BIRDS

Natural History of Birds

A Guide to Ornithology. By Leonard W. Wing. Pp. xi+539. (New York: The Ronald Press Company, 1956.) 6.75 dollars.

Recent Studies in Avian Biology

Edited by Albert Wolfson. Pp. ix+479. (Urbana, Ill.: University of Illinois Press, 1955.) 7.50 dollars.

THESE two works, both from America, are very different in aim. The first represents the biological approach to the study of birds; the second reflects the contribution of ornithological research to general biology and has the wider appeal.

Wing's volume is in fact a text-book, or work of general reference, intended to be used in conjunction with a field guide to the species of the area. It is at only a moderately advanced level, being addressed to the serious amateur as well as to the student; and it deals mainly with the bird as a living thing, giving only brief treatment of the basic facts of structure and function and the general principles of evolution and taxonomy. Thereafter it is concerned mainly with distribution and ecology and with the habits related to different aspects of life. There are concluding chapters on diseases, conservation, economic relations and methods of field study. The book is handsomely produced and very clearly illustrated. It is, however, naturally written for a North American audience and draws most of its examples from the bird-life of that region.

The second work consists of contributions by a dozen American authorities, who deal with subjects varying in the degree to which they have general rather than mainly specialist interest. There are discussions of systematic problems in relation to evolutionary processes (Miller) and of the biological significance of recent revisions of classification (Friedmann): here ornithologists have the advantage of the relative completeness of the systematic description of their material. Then there are accounts of advances in the study of fossil forms (Wetmore) and of some problems of anatomy (Fisher), the latter a rather neglected aspect nowadays. The study of behaviour in birds is the subject of a general essay (Emlen), followed by articles on bird navigation (Griffin), the physiological stimulus to migration (Farner) and nocturnal observations of migratory passage (Lowery and Newman)—fields in which the ornithologist can give a general lead. Breeding biology (Davis) and the role of hormones in sex differentiation (Domm) provide two further topics; as do population problems, studied respectively in gallinaceous birds (Hickey) and by 'banding' (Farner). A final article is on diseases of wild birds (Herman), a subject in which there is still very much to be done.

The articles, with their lists of references, constitute valuable guides to the newer knowledge and recent thought in the subjects covered.

LANDSBOROUGH THOMSON

THE ADRENAL GLAND

The Adrenal Cortex

By Dr. I. Chester Jones. Pp. x+316+9 plates. (Cambridge: At the University Press, 1957.) 37*s.* 6*d.* net.

THE adrenal gland has been the subject of a number of treatises in the past twenty years and one might have thought that, apart from the advances in the chemistry and physiology of their hormones in recent years, much of what can be said has already been published. In some respects a good deal of the present volume is in fact a repetition of what has already been written in previous volumes; nevertheless it is presented in an interesting fashion and is well integrated into the rest of the subject-matter. The book begins with a study of the adrenal glands in Eutheria, dealing with their gross anatomy, histology, their hormones, their control and their functions, and particularly their relationship to various tissues, for example, cartilage, bone, skin, lymphatic and connective tissues. There is also a discussion of adrenal gonad relationships and some naturally occurring abnormalities of function. Later chapters deal with the adrenals in the fish, amphibians, reptiles, birds, monotremes and marsupials, and with embryology and the correlation of structure and function.

Although the size of the text is relatively small (only 245 pages) it is unusually well documented, with a list of approximately 770 references. This, of course, adds enormously to the value of the book, particularly in view of the fact that the author has included practically all the major and important contributions to the literature of the adrenal in the various aspects with which he deals. Another valuable feature of the book is that the author has been able to draw upon his own extensive researches and those of the group working on comparative embryology at Liverpool in writing it, and this has obviously coloured his discussion and made the book much more than just a readable compendium of the literature. However, the attempt to review critically such an enormous field, with the support of so many references in so few pages, does make the book a little over-condensed in places and does not enable the author to do justice to many aspects which could have been developed. Nevertheless it is an excellent book for the many types of people working in this field—the zoologist interested in the adrenal will read with interest the clinical part and the clinician will no doubt find much to stimulate and intrigue him in the comparative anatomical and physiological aspects presented in it. Both will no doubt find much of pleasure and profit in the final chapter which discusses and attempts to find a "correlation of structure and function" in the adrenal.

G. H. BOURNE

Die Kupferchlorid-Kristallisation in Naturwissenschaft und Medizin

Von Dr. A. Selawry und Dr. O. Selawry. Mit einer Einführung in die kristallographischen Grundlagen von Prof. A. Neuhaus. Pp. xl + 232 (11 plates). (Stuttgart: Gustav Fischer Verlag, 1957.) 43 D.M.

THE growth-habit of crystals is often sensitive to small quantities of surface-active material in the environment, and proteins are among the particularly active habit-modifiers. When the crystal naturally tends to the forking needle type of growth which leads to spherulites, quantitatively slight changes in growth rate and forking frequency make qualitatively obvious changes in the crystallization picture. $CuCl_2.2H_2O$ is an example of a crystal showing this behaviour from aqueous solution, giving an *a priori* possibility that it might afford a sensitive test of some value in serological investigation. The method, which has been enthusiastically pursued by various workers since it was started by Pfeiffer (inspired by Rudolf Steiner) in 1930, is to add a small quantity of tissue extract to copper chloride solution crystallizing in a shallow dish, and to look at the resulting crystallization pattern. The two principal authors of this book are among the enthusiasts. Neuhaus contributes a sober, conservative and mainly accurate account of the scientific background of the subject. The fact that a scientic re-examination of the method has been commenced in his laboratory is to be welcomed. His opinion appears to be not very different from that of the reviewer, namely, that under careful control, and with a morphogenetic rather than a morphographic analysis of the results, such tests may be of some value; but that it is very unlikely that, as the principal authors consider, various simple geometrical elements of the pattern can be taken as directly diagnostic of a large variety of pathological conditions. While these are the methods of analysis, there can be little doubt that, even though there be truth in them, they cannot fail to be conducive to quackery. Some statistical tabulations showing reliabilities of the order 80 per cent are given, but not in a form designed for the persuasion of sceptics: the sceptical approach is foreign to the authors' nature. The book, including numerous good photographs, is beautifully produced, and those who are interested in spherulitic crystal growth (a subject with many queer byways) may consider adding it to their collection.

F. C. Frank

Irradiation Colours and Luminescence

By Dr. Karl Przibram. (Translated and revised in collaboration with the author by John Espenett Caffyn.) Pp. xiv+332. (Pergamon Science Series: Physics, Vol. 1.) (London: Pergamon Press, Ltd.) 63*s*. net.

THE author, now emeritus professor of physics in the University of Vienna, has devoted many years of patient research to the elucidation of the very complex phenomena of the coloration of minerals and their luminescence under various conditions. The results of his studies he presented in 1953 in a book which is primarily devoted to the description of his own observations but discusses them in the light of general physical theories. The very favourable reception of this work by physicists and mineralogists created the demand for an English translation. This, unfortunately, was published only after a lapse of nearly four years after the completion of the German manuscript. It would obviously have been desirable to re-write those parts in which progress has been most marked, but collaboration between author and translator was apparently not close enough for this task; only the survey of the literature at the end of the book has really been brought up to date.

It is still more regrettable that the translator did not always avoid the well-known pitfalls of rendering a German text into English. The shortcomings range from misunderstandings of words to a rather heavy and occasionally even obscure style. Already on the second page one is astonished to read that Faraday in his diary—jotted down only for his own use—is thanking his assistant; a comparison with the German original reveals that the difficulty of distinguishing between *denken* and *danken* (to think and to thank) was too much for the translator. Nor did he recognize the frequent necessity of breaking up long German periods into several English sentences.

The most valuable part of this English edition is the considerably enlarged survey of relevant publications. Thanks mainly to the contributions by the author, some 500 references have been added; the new compilation seems as reliable as the shorter list in the German book and can be regarded as a very welcome new edition of it. It may also be mentioned that since the publication of that book the author himself has given a summary of its contents in English in an article (*Endeavour*, **13**, 37; 1954) which is distinguished by excellent colour reproductions of some of the minerals described.

F. A. Paneth

Automatic Process Control for Chemical Engineers

By Prof. Norman H. Ceaglske. Pp. xiv+228. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1956.) 6.75 dollars; 54*s*. net.

THIS book is intended to form the basis of an undergraduate course of some forty-five to fifty hours with practical work in addition, for chemical engineering students in an American university. Its emphasis is on the theoretical aspects of automatic control and the mathematical methods available for expressing control system behaviour quantitatively. The treatment is elementary in that it deals with simple ideal systems, but not so elementary that it shuns the use of the Laplace transformation and many of the other techniques developed in the servomechanism field, although prior knowledge of these is not assumed.

The first two chapters discuss qualitatively and quite briefly the individual elements that make up a control loop, and here the author gives the impression of impatience to reach the quantitative approach which occupies the remaining two-thirds of the book; some of the illustrative graphs in this first section are open to criticism. The value of the book lies in the remaining five chapters in which the transfer function for each element of the loop is derived and the behaviour of the loop, subjected to stepwise or sinusoidal disturbances, is evaluated. The stability of the closed loop and the methods of arriving at a suitable controller gain are considered. The practising chemical engineer will find this book invaluable in his efforts to change a qualitative approach to a quantitative one and it is to be hoped that it will stimulate a more thorough teaching of this important subject in universities.

G. H. Anderson

EXPERIMENTAL DEMONSTRATIONS AND THE ROYAL INSTITUTION

By Sir LAWRENCE BRAGG, O.B.E., F.R.S.
Fullerian Professor of Chemistry in the Royal Institution

DURING the past three years, the Royal Institution has arranged a series of talks illustrated by experimental demonstrations for young people from the schools in and around London. These talks are held during the school year, and the tickets are distributed through the chief education officers of London and the Home Counties. Talks to young people are, of course, given from time to time at many centres in Britain; the Royal Institution has itself a long-standing tradition with its well-known Christmas lectures 'adapted to a juvenile auditory'. The present venture has, however, certain novel features. The lectures are not on some specific subject; each lecture or course is planned to illustrate a branch of science such as electricity, waves and vibrations, properties of matter. An attempt is made to stage experiments on a large and striking scale, and these experiments demonstrate general principles. The object is to show the boys and girls experiments which they read about in their textbooks but which are too complex or on too large a scale for it to be generally possible to stage them with school resources. The holding of a series of talks throughout the year makes it possible to issue quite a large number of tickets. The scheme has been growing, and some 16,000 tickets will be available for lectures next year. This number by no means satisfies the demand, but it does mean that during the final two years in the science forms quite a large proportion of the keen pupils will have at least one opportunity to visit the Royal Institution and to see the types of experiment we can show. The central position of the Royal Institution and its large theatre are of great advantage. It is within a few minutes of Piccadilly Circus and perhaps one-quarter of the population of England is included in the area from which an afternoon visit can conveniently be made. No charge is made for the tickets, and the cost of running the courses is met by generous contributions from industrial firms and other organizations, which appreciate the benefit of such courses in stimulating an interest in science and in scientific careers.

The success of the scheme has been very largely due to the warm co-operation of the science masters and mistresses. We have a small advisory committee of science teachers, and try to meet their wishes as to the type of treatment they would like for their pupils in order to supplement their own class teaching. No attention is paid to the requirements for examinations. The object is to stimulate interest, and to help the young people to grasp principles by simple but impressive experiments of a kind likely to be remembered. The lectures are in fact part of a larger scheme of co-operation with science teachers in schools. We are trying to make in the Royal Institution a centre which can be of service to them in their vitally important task of training the next generation of scientists. For example, regular occasions are arranged on which a party of seventy to a hundred science teachers visits the Royal Institution for the afternoon, and there meets the leader of some well-known research school and members of his team. After a preliminary talk, the teachers split into small groups and talk informally with the people who are doing research. They hear of the work which is just coming out, and have an opportunity of personal contact with men who are well known in the scientific world. These occasions are, I think, appreciated because in the bewilderingly rapid advance of science it is so hard to keep abreast of recent work, and a summary by a well-known leader enables the visitors to get a grasp of what is really important and essential.

The library is rich in periodicals and books of reference, and specializes in the history of science and in popular books on science. The Institution has a large store of apparatus and models, and this collection is being augmented by the purchase of the more advanced types of apparatus for demonstration purposes which are made in Britain and abroad. A 'library subscribership' is being initiated which entitles teachers of science in schools and technical colleges to use the library and reading room and to have access to the teaching apparatus so that they can get ideas for the demonstrations which they show to their classes. It is a common experience that even the apparently simplest experiment demands much time and study if it is to work properly, and it is hoped that the experience gained in the Royal Institution theatre may be of service to the teachers in saving some of their effort.

The success of the lectures depends on the staging of experiments on the grand scale. It would scarcely be economic to attempt this for small audiences. The lecture theatre holds five hundred, however, and since each lecture is given four times in the course of a fortnight, it is attended by two thousand pupils, so that it is really worth while to assemble a fine display. We are helped by industrial and government research laboratories, who have been most co-operative in lending us gear of all kinds, and in many cases by providing assistants to service it. The value of the apparatus and examples in the lecture theatre and ante-room must often run into thousands of pounds. An experiment which lasts five minutes in the lecture theatre may have required as many weeks of skilled planning and workshop time.

The lectures are for the most part on physical subjects, because the Royal Institution is best equipped in this field. Next year there will be five physics lectures, one chemical and one biological, for the top science forms with pupils between sixteen and eighteen years of age. A special lecture is given at the end of the year to fourth-form pupils, in the hope that some who are still undecided may choose a scientific career. As each lecture is given four times, the total for the year is thirty-two.

The keen interest of the young people who come to the demonstrations is most encouraging, and I

think there can be no doubt that the scheme is meeting a need and giving them something which they greatly appreciate. As has been said above, its success depends on its scale, and it cannot be carried out cheaply. But the investment is a small one for a large return if it inspires a love of science in any reasonable proportion of the young people who attend, and if it helps the science teachers in their task. Similar ventures in some half-dozen other great centres of population would cover practically the whole of Great Britain. I should like to testify to the surprisingly warm reception of this project, which has exceeded all our expectations, in the hope that our experience may be of use elsewhere. I wish also to express on behalf of the Royal Institution our warmest thanks to the industrial firms and other organizations which have made this project possible by their generous contributions.

THE SAFETY IN MINES RESEARCH ESTABLISHMENT, MINISTRY OF POWER

ON April 25 the Minister of Power, Lord Mills, opened the first part of the laboratories re-housing the Safety in Mines Research Establishment in Sheffield. In doing so, he spoke of the long and honourable ancestry of the Establishment, pointing out that safety in mines research goes back at least as far as Sir Humphry Davy, and that the present laboratories have an unbroken link with 1908, when the Mining Association of Great Britain put in hand researches at Altofts Colliery, Yorkshire, first to settle the disputed question whether coal dust alone (that is, without the assistance of fire-damp) could propagate a mine explosion, and secondly, to find a remedy for explosions in mines. They asked Mr. W. E. Garforth to supervise the experiments and appointed Dr. R. V. Wheeler as chemist and physicist. Wheeler directed the work, as it developed under various authorities, until his death in 1939.

In 1910 the Home Office undertook responsibility for the work and moved it to Eskmeals on the coast of Cumberland. In 1920 the experimental station was transferred to the Mines Department of the Board of Trade, and in 1921 the Miners' Welfare Committee decided to make capital grants for new and more centrally situated research stations and to give these stations financial support. In the same year, Dr. Wheeler was appointed to the chair of fuel technology in the University of Sheffield, while remaining director of the laboratories of the newly appointed Safety in Mines Research Board. In 1927 a new field station was opened near Buxton by the chairman of the Miners' Welfare Committee, Viscount Chelmsford. On 90 acres of moorland, ample facilities were made available for such experiments on explosions, explosives and fires as could not be tolerated in an urban area. In 1928 central laboratories were opened by the Prime Minister, Mr. Baldwin, in Portobello Street, Sheffield.

Lord Mills commented on how greatly the work had expanded since the early days. "As Minister of Power," he said, "I am charged, under the Coal Mines Nationalization Act of 1946, with a special responsibility to secure the prosecution of research into methods of advancing the safety and promoting the health of persons employed in or about coal mines, and it is to the Safety in Mines Research Establishment I look for the discharge of a large measure of that responsibility."

The programme of research has steadily widened until to-day it applies to all the important hazards in mining. A fuller understanding of the chemical and physical background of these dangers is sought with the conviction that it will lead to greater safety in mines.

The new building is occupied jointly by the engineering group and the technical information services. The engineering group has sections dealing with metallurgy, stresses in haulage and winding gear, underground supports (for example, props and bars employed in roof support), and wire ropes. The group also provides a design service to the whole Establishment, and includes a section engaged in the development of special instruments needed by the industry or the Establishment.

Metallurgical studies are made on the causes of deterioration (such as strain-age embrittlement), on the appropriateness or otherwise of various steels and their heat treatment, and on the virtues and defects of various methods of fabrication. Fundamental

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Fig. 1. Safety in Mines Research Establishment new building at Sheffield

[Crown copyright

Fig. 2. Interior of large engineering laboratory

work is in progress on fatigue of metals because of its importance as a source of catastrophic failure. Much use is made of non-destructive examination (for example, of the welds in chain-links), the most useful techniques being magnetic crack detection, radiography and ultrasonics.

Mining gear undergoes severe usage, and there is a need for further knowledge on the dynamic loads and stresses in winding and haulage components. The section concerned employs the now classical methods of calculation, photoelastic examination of models in plastics, and dynamic stress measurements.

Hydraulic and friction props for roof-support in mines have occasionally been reported as liable to load-shedding; the conditions under which this may occur are being ascertained. Some props that are specially designed to engage with the corresponding bars have been found to be difficult to remove safely; a device that allows this to be done has been designed and is being tried underground. Steel arches and roof-bars are often joined by fish-plates; suitable dimensions for preserving the strengths of such joints have been worked out. Haulage and winding ropes, and their proper attachment to their loads, have long been the subject of investigations; but the introduction of new methods of winding into British coal mines has brought up new problems.

The mathematics section is also housed in the new building. This section was initiated relatively recently, and for the first few years its programme was dominated by statistical studies. Statistical treatment of accident returns led to the development of a simplified procedure for assigning significance to the figures, for the particular use of mine managements. This procedure has been accepted by the National Coal Board, and there is some evidence that its adoption will lead to a fall in the accident rate by virtue of the clear picture of the situation revealed to the management. Statistics are also much in demand for planning experiments in the elaborate empirical investigations that are often necessary. However, to-day the accent is passing from statistics to mathematical examinations as a preliminary to major experimental investigations.

The technical information services include artists, photographers, editorial staff and librarians. This section ensures that the results of the researches are presented in a clear and assimilable form. In addition, the section plays an active part in the scientific work of the Establishment. Films are made when the visual content of a research is of importance; the films made of experiments on the mode of dispersion of dust in air are excellent examples of the value of the technique. The library has a fine collection of works relating to health and safety research and maintains a translating and abstracting service.

Apart from the work to be done in the new building, other subjects of major importance to safety in mines are the old problem of explosions of coal dust and fire-damp (particularly as affected by modern methods of mining), the safe use of mining explosives and of electrical equipment, the fire hazard in mines, and, very importantly, the prevention of pneumoconiosis. Many aspects of these subjects, except the last-named, can only be dealt with in open spaces and will therefore remain to be investigated at the existing experimental station near Buxton. Other work on them, including that on the physics and chemistry of dusts causing pneumoconiosis, will have to continue to be housed in the overcrowded laboratories in Portobello Street, Sheffield, until the building scheme for the laboratories just opened is completed.

The staff are in touch with many other related organizations. Contracts have been placed for work to be done on certain problems by specialists in several universities. Close collaboration with H.M. Inspectorate of Mines is maintained, especially when investigations have been advanced to the stage where practical mining applications seem possible. There is close association with the National Coal Board and its Scientific Department, with the Department of Scientific and Industrial Research, the British Electrical and Allied Industries Research Association, the Factory Department of the Ministry of Labour and National Service, the Joint Fire Research Organization, the Pneumoconiosis Research Unit, and other research bodies.

International co-operation has been based on biennial conferences of Directors of Safety in Mines, the first full conference having been sponsored by the Safety in Mines Research Board and held in England in 1931.

As to the future of research on safety in coal mines, the Minister, after emphasizing the continuing reliance of our economy on coal despite all foreseeable contributions from nuclear energy, said that "A steady and continuous fight must be waged by scientists and engineers to ensure that the development of mining machinery and techniques is matched by advances in safety. This is predominantly the mandate of the S.M.R.E.".

BIOCHEMICAL APPROACHES TO THE PROBLEM OF PROTEIN SYNTHESIS*

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EVERY species of living organism produces its own specific proteins, and this specificity is inherited in successive generations. The recent structural studies of Sanger[1] on insulin and of Tuppy and Paléus[2] on cytochrome-*c* strongly suggest that species specificity is expressed as an exact amino-acid sequence within each protein; thus, the problem of protein biosynthesis is at once the problem of peptide bond formation and the problem of sequence control. The solution to the first problem may well hold within it the solution to the second, but, for the sake of clarity, it is preferable to discuss the two separately.

Peptide Bond Formation

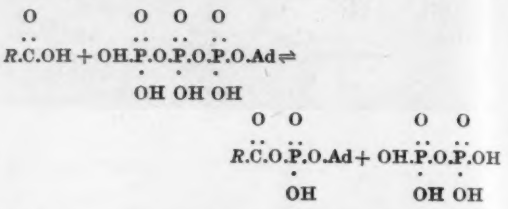
Reaction between the carboxyl group of one amino-acid and the amino-group of another to form a peptide bond does not occur to any significant extent in aqueous solution. The reaction may be catalysed by proteolytic enzymes; but in every case the equilibrium point of the reaction is overwhelmingly towards hydrolysis rather than synthesis. The intracellular cathepsins have been, nevertheless, seriously considered as possible catalysts for protein biosynthesis, mainly because other enzymes capable of catalysing peptide bond formation were, until recently, unknown. Now evidence has accumulated[3] to suggest that peptide bond formation takes place through intermediate formation of energy-rich phosphate derivatives of amino-acids, and several enzymes have been purified which, in the presence of adenosine triphosphate, catalyse amide-bond formation.

The synthesis of glutathione from glutamylcysteine and glycine takes place according to the overall reaction:

Glu.Cys + Gly + adenosine triphosphate ⇌
Glu.Cys.Gly + adenosine diphosphate + orthophosphate

Snoke and Bloch[4] have purified the enzyme catalysing this reaction and have suggested that glutamylcysteinyl phosphate may be formed as an intermediate. An enzyme which catalyses the formation of glutamine from glutamic acid and ammonia in the presence of adenosine triphosphate has also been purified[5]. The mechanism of the reaction has been studied in great detail using isotopic phosphorus and oxygen and there is now little doubt that glutamyl-γ-phosphate is formed as an intermediate[6]. In neither of these syntheses, however, has it been possible to isolate the intermediate phosphorylated derivative from the reaction mixture, presumably because it is firmly bound to the enzyme surface until reaction with amine takes place.

Three other examples of amide-bond formation, the acetylation of sulphanilamide[7], the synthesis of hippuric acid[8] and the synthesis of pantothenic acid also require adenosine triphosphate, but in each case the products of the reaction, besides amide, are adenosine monophosphate and pyrophosphate. Maas[9] has shown that, in the reaction between pantoic acid and β-alanine, the first step is an enzyme-catalysed formation of an adenylic acid anhydride of pantoic acid according to the reaction scheme shown below, where Ad = adenosine and $R = CH_2OH{\cdot}C(CH_3)_2{\cdot}CHOH{\cdot}$



Thus, it would seem that carboxyl activation by means of adenosine triphosphate generally involves formation of a mixed carboxyphosphate anhydride, the phosphate moiety being either phosphoric acid or adenylic acid according as to whether adenosine diphosphate or adenosine monophosphate is the final product of the reaction.

There is evidence that protein synthesis is a process dependent on adenosine triphosphate[3] and it was therefore reasonable to look for enzymes which would activate the carboxyl groups of amino-acids through the mediation of adenosine triphosphate.

Amino-acid Activating Enzymes

Hoagland[10] made the important observation that, in the presence of adenosine triphosphate, a soluble enzyme preparation from rat liver would activate the carboxyl groups of amino-acids. In the presence of hydroxylamine, amino-acid hydroxamates were formed, together with adenosine monophosphate and pyrophosphate; the reaction thus resembled pantothenic acid synthesis rather than glutamine synthesis. On the assumption that the most likely intermediates were adenylic anhydrides of amino-acids, several compounds of this type were synthesized in different laboratories[11]. Although such mixed anhydrides are chemically unstable with half-lives of less than 30 min. at 37° at physiological *p*H, they are sufficiently stable at low *p*H to permit isolation[11,12]. DeMoss and Novelli[13] have obtained from bacteria a soluble enzyme preparation which activates leucine in the presence of adenosine triphosphate. This enzyme preparation will, in the presence of pyrophosphate, catalyse the conversion of synthetic adenyl–leucyl anhydride into leucine with the formation of adenosine triphosphate.

Amino-acid-activating enzymes which are dependent on adenosine triphosphate are widely distributed; thus, Cole, Coote and Work[14] have obtained active preparations from kidney, muscle, pancreas, gut wall and mammary gland of various animals, while Berg[15]

* Substance of two lectures delivered by Dr. T. S. Work at University College, London, on February 18 and 25.

has reported a methionine-activating enzyme in yeast. A purified specific tryptophan-activating enzyme can readily be obtained from ox pancreas[16] and partial purification of liver enzymes activating several amino-acids has also been reported[17].

Hoagland, Keller and Zamecnik[17] have shown that a partially purified enzyme preparation from rat liver will catalyse the incorporation of amino-acids into rat liver microsome protein *in vitro*, provided that adenosine triphosphate and guanosine di- or tri-phosphate are added to the system. The possible function of the guanosine derivative will be discussed later.

Since only one amino-acid-activating enzyme has so far been purified, it is uncertain whether there is a specific enzyme for each amino-acid; but present indications are that such specific enzymes will be isolated. The activation of the carboxyl groups of amino-acids by these enzymes may well be a first step towards peptide-bond formation in the synthesis of proteins. It has been found, however, that adenyl anhydrides of amino-acids polymerize spontaneously under physiological conditions, so that any scheme for protein synthesis involving these intermediates must also involve a control mechanism which prevents random polymerization. It is generally thought that nucleic acids are involved in this control mechanism.

Nucleic Acids in Protein Synthesis

There is much evidence to suggest that inherited characters are transmitted through the nuclear apparatus, specifically, in the more developed cells at least, by the chromosomes, which are rich in deoxyribonucleic acid. From the recent studies of Sanger[1], it would appear likely that inherited character is expressed somatically by strict control of protein structure, and it is reasonable to believe that the nucleic acids of the chromosomes exercise this control.

Direct evidence that deoxyribonucleic acid can influence the protein composition of cells has come from several sources. For example, in bacteria, exposure to an appropriate purified deoxyribonucleic acid can bring about type transformation phenomena involving the acquirement of new enzymes[18]. Hershey and Chase[19] have shown also that infection of *Escherichia coli* by bacteriophage results in the entry of only bacteriophage deoxyribonucleic acid into the cell, yet the bacterium is then able to synthesize bacteriophage protein. Whether, in these instances, there is direct control of protein synthesis by the new deoxyribonucleic acid which has entered the cell is at present unknown.

It was originally assumed that, in higher organisms, proteins were synthesized in the nucleus under the direct control of the nuclear deoxyribonucleic acid; but it has now been shown that protein synthesis can continue in the cytoplasm of enucleated cells. Thus, Brachet[20] has shown that when the nucleus is removed from the marine alga *Acetabularia*, protein synthesis, including the formation of specific enzymes, continues in the cytoplasm. It has been shown in other cells also that neither synthesis nor turnover of deoxyribonucleic acid is necessary for protein synthesis. Spiegelman and his colleagues[21] exposed bacteria to lethal doses of X-rays and found that although the bacteria could no longer synthesize deoxyribonucleic acid, both protein synthesis and ribonucleic acid synthesis were unimpaired. Cohen and Barner[22] showed also that the maintenance of thymine deficiency in a thymine-less mutant of *Escherichia coli* reduced or abolished deoxyribonucleic acid synthesis without at the same time damaging induced enzyme formation. The above remarks should not be taken as implying that deoxyribonucleic acid has no part to play in the synthesis of proteins in the normal intact cell.

Association of Ribonucleic Acid with Protein Synthesis

Recent work on viruses has indicated that protein specificity may be controlled by ribonucleic acid as well as by deoxyribonucleic acid. Many plant and some animal viruses contain no deoxyribonucleic acid[23] yet they presumably provide a stimulus for the exact reproduction of virus protein structure. The recent work of Fraenkel-Conrat[24] supports this hypothesis. He showed that ribonucleic acid from one strain of tobacco mosaic virus could be combined with protein from another strain to yield an infective preparation. When this synthetic virus was allowed to infect plants, the new virus formed in the plants carried the protein of the strain of virus which had provided the ribonucleic acid of the artificial virus. It should be emphasized, however, that although viruses are often referred to as self-reproducing units, they are in fact only self-reproducing inside a cell which contains deoxyribonucleic acid, and so far as is known the process of self-reproduction in living matter always requires the presence of deoxyribonucleic acid.

It has been often stated that during growth, increase in protein is always accompanied by a parallel increase in ribonucleic acid, and from such observations has come the idea that protein synthesis cannot take place without simultaneous synthesis of ribonucleic acid. Growth is, however, a balanced process, and it would be surprising if there were no correlation between the synthesis of ribonucleic acid and that of protein during growth. The study of protein synthesis in micro-organisms, especially induced enzyme formation, has provided much evidence which seems at first sight to support this idea of a compulsory coupling between synthesis of protein and ribonucleic acid. The effect of various growth inhibitors has also been interpreted along similar lines.

Gale and Folkes[25] showed that chloramphenicol could inhibit protein synthesis specifically without at the same time inhibiting synthesis of ribonucleic acid. In general, however, inhibitors of ribonucleic acid synthesis produce simultaneous inhibition of protein synthesis. Thus, structural analogues of purines or pyrimidines which inhibit ribonucleic acid synthesis have been found to inhibit enzyme formation also[26]. Pardee[27] found, moreover, that a uracil-deficient mutant of *Escherichia coli* which could not synthesize ribonucleic acid in the absence of uracil was also unable to synthesize enzymes unless uracil was supplied.

Not all the evidence obtained using micro-organisms supports the idea of compulsory coupling between ribonucleic acid synthesis and protein synthesis; thus, Hotchkiss[28] found that uptake of radioactive phosphate into the nucleic acid of non-dividing staphylococci was inversely related to the rate of protein synthesis. It thus seems unlikely that there is a direct requirement for simultaneous ribonucleic acid synthesis during protein synthesis. The effects

of inhibitors could be explained if it is assumed that mononucleotides or small polynucleotides are necessary for protein synthesis. We shall return to this point later.

Ribonucleic Acid and Protein Synthesis in Mammalian Cells

Induced enzyme formation is not available as a ready tool for following protein synthesis in mammalian cells, and other methods of exploring the relationship between ribonucleic acid and protein synthesis have had to be used. Hokin[29] followed amylase synthesis in slices of pigeon pancreas and found no relationship between amylase synthesis and ribonucleic acid turnover. There have been reports also that ribonucleic acid turnover is relatively low in organs such as the oviduct[30] which are particularly active in protein synthesis. Whole organs are, however, not an agglomeration of identical cells nor is the turnover of ribonucleic acid in a whole organ an adequate measure of ribonucleic acid turnover at the site of protein synthesis. Munro[31] has recently suggested that the stability of ribonucleic acid in rat liver is determined by the supply of amino-acids for protein synthesis, ribonucleic acid breaking down when the availability of amino-acids is reduced.

An alternative criterion of protein synthesis is uptake of isotopically labelled amino-acid into peptide linkage. The criterion is probably reliable, at least for secretory organs such as pancreas, liver or mammary gland, since it has been shown that the secreted proteins are synthesized *de novo* from amino-acids[32]. Liver has the practical advantage that it consists predominantly of parenchymal cells which are readily ruptured without serious damage to the subcellular structures. In 1950, Hultin and others[33] showed that, shortly after administration of labelled amino-acids to the normal animal, much of the isotope could be found bound in peptide linkage in the protein of the microsome fraction of the liver cells. The proteins of the mitochondria, nuclei and the soluble cell sap were less rapidly labelled. A similar pattern of labelling has since been found in both kidney and pancreas[34].

In liver, the microsomal fraction is derived largely by fragmentation of the endoplasmic reticulum, a complex of membranes which permeates the cell cytoplasm and attached to which are large numbers of small electron-dense granules (about 150 A. in diameter)[35]. It also contains much of the cytoplasmic ribonucleic acid which, according to Palade and Siekevitz[35] is concentrated in the electron dense granules. Several groups of workers have now fractionated the labelled microsome material isolated from livers of animals previously given a single dose of labelled amino-acid. Simkin[36] extracted the microsome fraction successively with solutions of differing ionic strength and *p*H. Of five subfractions so obtained from guinea pig liver, one (*A*) contained only protein, two (*B* and *C*) were ribonucleoprotein, and two (*D* and *E*) were lipoprotein. The protein of fraction *C* (which had a protein : ribonucleic acid ratio of about 3 : 1) had a particularly high turnover-rate, whereas the protein of fraction *B*, despite its association with ribonucleic acid, had a low rate of turnover.

Littlefield, Keller, Gross and Zamecnik[37] have fractionated the microsome material from rat liver by treatment with deoxycholate. This dissolves the lipoprotein and leaves insoluble the electron-dense granules which can then be separated by high speed centrifugation. The protein of these ribonucleoprotein granules was found to have a much higher turnover-rate than the remainder of the microsome material. This association of protein of high turnover-rate with ribonucleic acid is not confined to liver; thus, for example, when reticulocytes were incubated with ^{14}C-leucine, a ribonucleoprotein fraction became labelled first and then lost activity as haemoglobin became radioactive[38]. In pancreas[34] and in muscle[39] also a protein fraction with a high turnover-rate was associated with ribonucleic acid. In a variety of mammalian systems, therefore, the evidence suggests that ribonucleic acid is of importance for protein synthesis.

Since the suggestion had been made that induced enzyme formation involved simultaneous synthesis of ribonucleic acid, we have measured ribonucleic acid turnover in the guinea pig liver microsome subfractions *B*, *C* and *D* referred to above. It was found that at the time of maximal labelling of the protein of fraction *C*, there had been little uptake of phosphorus-32 into the ribonucleic acid of this subfraction[40]. Thus, in this system at least, if phosphorus-32 incorporation is a measure of ribonucleic acid turnover, protein synthesis does not appear to require simultaneous synthesis of ribonucleic acid. It must be remembered, however, that microsomal ribonucleic acid is heterogeneous with respect to phosphorus-32 turnover and that some small fraction of it could have a much higher turnover-rate than the whole[40,41].

Protein Synthesis in Cell-free Preparations

Greenberg and his colleagues[42] first showed that tissue homogenates would incorporate labelled amino-acids into trichloroacetic acid-precipitable protein. Later, Siekevitz[3] showed that liver homogenates resembled whole liver in that the protein of the microsome fraction became much more rapidly labelled than that of other subcellular fractions. It thus seemed likely that incorporation of ^{14}C-amino-acid into the microsome fraction *in vitro* was some part of the mechanism of protein synthesis. This incorporation certainly involves formation of peptide bonds since Zamecnik *et al.*[43] have been able to isolate radioactive peptides following partial hydrolysis of protein labelled *in vitro*.

The whole homogenate is not required for incorporation of amino-acids into microsome protein. Thus, Zamecnik and Keller[44] were able to obtain rapid incorporation lasting for about 10–20 min. in a system containing only microsomes plus cell sap, provided the system was supplemented with a source of adenosine triphosphate. Later they were able to show, together with Hoagland[17], that the cell sap could be replaced by a crude preparation of amino-acid-activating enzymes, together with guanosine di- or tri-phosphate and adenosine triphosphate[45]. It is particularly interesting, therefore, that a guanosine monophosphate-like compound should have been found by Davie, Koningsberger and Lipmann[18] to be a firmly bound component of the purified tryptophan-activating enzyme. There is here, again, evidence to suggest that mononucleotides play an essential part in protein synthesis.

Since, with microsomes, we are measuring amino-acid incorporation into undefined trichloroacetic acid-precipitable protein and not synthesis of some one

specific protein, it behoves us to look at the characteristics of this process more closely. Exposure of the microsome material to ribonuclease reduces the capacity to incorporate amino-acids[34,46] and microsome material labelled *in vitro* was found by Littlefield *et al.*[27] to yield a deoxycholate-insoluble ribonucleoprotein fraction of high specific activity. In this respect it resembled material labelled in the intact animal, but we have recently shown that this resemblance may be more apparent than real. Simkin and Work[46] labelled a cell-free microsome preparation from guinea pig liver with the same mixture of amino-acids used previously in the whole animal and then applied the successive extraction procedure described earlier[26]. It was found that the ribonucleoprotein subfraction *B*, which had a slow rate of turnover *in vivo*, had the highest rate of turnover *in vitro*, and that fraction *C* which became particularly rapidly labelled *in vivo* had relatively little activity *in vitro*. There is thus a very real problem of interpretation when considering incorporation in cell-free systems.

Perhaps one of the most satisfactory criteria of protein biosynthesis is the incorporation of radioactive amino-acid into a specific protein which can later be isolated and characterized. A suitable method for isolation on a small scale is immunological precipitation. This method was used by Peters and Anfinsen[47] for following albumin synthesis in liver slices, and it has been applied by Askonas[12] to follow the effect of cell injury upon protein synthesis. When slices of lymph gland from an immunized guinea pig were incubated with ^{14}C-glycine, there was a linear increase in radioactivity of newly synthesized antibody over a period of several hours. The antibody was isolated by specific precipitation with the appropriate antigen. There was, at the same time, a linear increase in activity of the insoluble proteins of the tissue slices. When the cells were damaged mechanically, uptake of radioactivity into specific antibody ceased at once; but uptake into insoluble proteins continued unabated. This result suggests that there may be several distinct stages in the synthetic process, some being more readily damaged by cell injury than others. Steinberg, Vaughan and Anfinsen[48] have recently summarized the arguments in favour of a stepwise process of protein synthesis. The relatively robust nature of the microsome-incorporating system compared to the labile nature of antibody synthesis may indicate that the formation of microsomal ribonucleoprotein is an early stage in the synthetic process. Various workers[49] have shown that the ribonucleoprotein granules of liver disappear on starvation and reappear again after feeding protein. This would not be inconsistent with these granules acting as storage depots for incomplete protein.

Several laboratories have reported an energy-dependent increase of enzyme activity in cell-free preparations. Thus, Ullmann and Straub[50] found that an extract of acetone-powdered pigeon pancreas could show an increase of approximately 50 per cent in amylase activity in the presence of amino-acids and adenosine triphosphate. Straub[51] has suggested that in this case an incomplete amylase is present in the extract and that the synthesis may be completed by addition of a few amino-acids to this precursor. Gale and Folkes[52] have shown also that staphylococci damaged by exposure to sonic oscillation may still be able to develop a substantial increase in enzyme activity on incubation with adenosine triphosphate and hexose diphosphate. This increase, like many examples of authentic protein synthesis in intact cells, is inhibited by chloramphenicol; it is also inhibited if nucleic acid is extracted from the damaged cells and restored by incubation either with purines and pyrimidines, ribonucleic acid or deoxyribonucleic acid. While these results are extremely suggestive, it would be desirable to show specific incorporation of ^{14}C-amino-acids into the enzymes, since increase in enzyme activity during incubation may arise from a variety of causes other than true synthesis.

Control of Protein Synthesis by Nucleic Acids

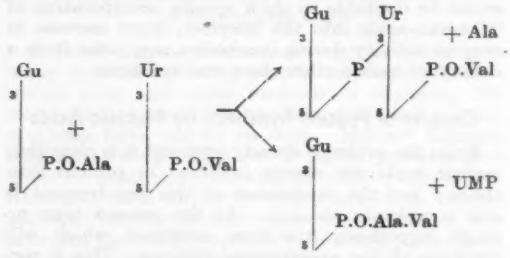
From the evidence already reviewed it is clear that nucleic acids are closely involved in protein synthesis; but the mechanism of this involvement is still completely obscure. At the present time no single hypothesis has been advanced which will reconcile all the experimental findings. This is perhaps not altogether surprising, since a variety of systems have been studied under widely varying physiological conditions, including both growing and resting cells as well as various subcellular preparations.

It now seems very likely that the first step in protein synthesis involves formation of amino-acid anhydrides of adenosine-5-phosphate. When such an anhydride is formed it is strongly attached to the enzyme surface and it will neither polymerize with itself nor react with free amines except when the latter are present in very high concentrations. The degree of specificity towards amine acceptor is well illustrated by the observation that glutamic acid does not react with hydroxylamine in place of cysteine in the presence of glutamylcysteine synthetase[53]. It would seem from the work of Zamecnik's group[45] that at some stage in the transfer of activated amino-acid from activating enzyme to acceptor a second nucleotide other than adenosine triphosphate may be required. Holley[54] has recently reported the occurrence of an alanine-dependent conversion, sensitive to the action of ribonuclease, of adenosine monophosphate into adenosine triphosphate in the soluble fraction of rat liver. He has suggested the occurrence of amino-acid derivatives other than the adenyl anhydrides. A requirement for individual mononucleotides in the transfer of activated amino-acids to their appropriate acceptors could explain many of the observations on the inhibition of protein synthesis by structural analogues of purines and pyrimidines[55].

Not only do these structural analogues inhibit protein synthesis, the converse is also true; Pardee and Prestidge[55] have shown that structural analogues of amino-acids inhibit ribonucleic acid synthesis. It has been found also, both by Gros and Gros[56] and by Pardee[55], that free amino-acids are required for ribonucleic acid synthesis in the apparent absence of protein synthesis. Schmidt and his co-workers[57] have suggested that in yeast the polymerization of nucleotides to form ribonucleic acid does not take place in the absence of conditions favouring protein synthesis. These results suggest that somewhere in the synthetic chain common precursors exist for both protein and nucleic acid synthesis, these common precursors being compounds of amino-acids with nucleotides (cf. Hotchkiss[28]).

Ochoa[58] has shown that nucleoside-5-pyrophosphates can polymerize under the influence of an appropriate enzyme to yield polynucleotides with release of inorganic phosphate; a chemically

analogous polymerization could take place starting from nucleotide-5-phosphate–amino-acid anhydrides according to the following scheme, where the two alternative pathways could lead to the formation of polynucleotide with release of amino-acid or to polypeptide with release of nucleotide.



While this scheme is no more than speculative, it would explain the mutual dependence of protein and ribonucleic acid synthesis on the supply of nucleotides and amino-acids. It might also explain the occurrence of induced enzyme formation in bacteria in the absence of an energy supply[59] since, in the starving cell, the small quantity of mononucleotides made available by degradation of cell nucleic acid would not be immediately used up in synthesis of ribonucleic acid. This hypothesis would be consistent also with the observation of Gale and Folkes[62] that the increase of β-galactosidase activity of disrupted *Staph. aureus* could be restored by incubation with a mixture of purines and pyrimidines, with the observations of Reiner and Goodman[49] that glucokinase formation in *Escherichia coli* was accelerated by exposure to a mixture of polynucleotides of varying size, and with the findings of Webster and Johnson[61] that uptake of radioactive glutamate into the protein of a particulate fraction from pea seedlings was stimulated by a mixture of nucleotides or purines and pyrimidines to an equal or greater extent than by partially degraded or intact ribonucleic acid.

While this common intermediate hypothesis is consistent with a number of experimental observations, it cannot by itself explain the control of amino-acid sequence, a key feature of protein synthesis. Several alternative hypotheses have been advanced to explain the apparent control of amino-acid sequence by nucleic acids; they may be conveniently grouped together as the template hypotheses. One feature they all have in common: they lack, so far, direct experimental support. It has been suggested that the nucleic acid template provides a surface upon which amino-acids can be arranged in appropriate order before being linked together. The nature of the bonds involved between amino-acids and nucleotides have been variously postulated to be N-phosphoryl or carboxy-phosphoryl[62]. It seems to have been generally assumed that there is a template for each protein molecule and presumably therefore that the template has similar dimensions to the complete protein molecule.

Since any hypothesis that envisages the synthesis of a protein as taking place in a single step on a template surface would be extremely difficult to prove experimentally, alternative hypotheses should be sought in the hope that they may give rise to fruitful experimentation. Information can be stored in any macromolecule; thus any enzyme when it reacts with its appropriate substrate and coenzyme is using stored information and is in a sense acting as a template. It seems unnecessary to suppose, therefore, that deoxyribonucleic acid of a virus entering a bacterium or the deoxyribonucleic acid of the transforming factor entering a pneumococcus must carry with it a complete replica of some new protein molecule which will be produced as a result of its entry. The recipient cell may already contain nearly all the information required for this new synthesis; the entering deoxyribonucleic acid might only have to change the kinetics of a single reaction to make this possible. It seems to us that deoxyribonucleic acid (or ribonucleic acid) might well undergo partial depolymerization to yield diffusible cofactors which could influence the order in which amino-acids were linked together.

It would certainly be interesting to ascertain whether the same amino-acid sequence results when amino-acid anhydrides are polymerized in the presence of different small polynucleotides. Problems such as these are open to experimental verification.

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MINERAL BENEFICIATION AND EXTRACTIVE METALLURGICAL TECHNIQUES

SYMPOSIUM AT JAMSHEDPUR, INDIA

FOLLOWING the practice established soon after the inauguration of the National Metallurgical Laboratory at Jamshedpur in 1950, another symposium was held during February 8–11 this year. The symposium was opened by Sir J. J. Ghandy, director-in-charge of Tata Industries, Ltd., and inaugurated by Prof. M. S. Thacker, director-general, Scientific and Industrial Research in India. Many guests and speakers attended from overseas countries, including Sir Charles Goodeve, director of the British Iron and Steel Research Association.

This symposium may be regarded as one of the most important yet held in India, since the diverse subjects discussed all had a bearing on the development and ultimate success of the Indian Government's second Five-Year Plan.

During the four days of the conference, fifty-three papers were presented in seven sections, and opportunities were afforded of visiting the National Metallurgical Laboratory. The papers covered ore preparation, beneficiation and extractive techniques used in the production of iron, manganese, chromium, titanium, aluminium, uranium, copper, beryllium, lead, zinc, antimony and gold. A number of papers were presented by the staff of the National Metallurgical Laboratory dealing with recent research on extractive methods which are likely to be adopted in the expanding metallurgical industry of India. An important section of the symposium included papers on coal preparation and washing, and the beneficiation and reduction of the siliceous Salem ores of Southern India, using lignite as the fuel.

India is extremely fortunate in possessing large deposits of almost every type of mineral, with the exception of nickel, but fuel supplies are small. The availability of high-quality coking coal is limited to only a few years. While India has ample mineral resources, in order to develop successful metallurgical industries it must be by the utilization of extractive techniques which require the minimum quantities of high-grade solid or even liquid fuels. Hence beneficiation of metallic ores is of paramount importance, associated with the use of electrolytic or electrical refining. When the use of solid fuel is unavoidable, recourse should be made to the use of lignites or charcoal.

In a paper entitled "The Role of the National Metallurgical Laboratory", Dr. B. R. Nijhawan, organizer of the symposium, who has recently been confirmed in the post of director of the Laboratory, directed attention to the quantities of basic materials imported into India in relation to the present annual consumptions and the targets fixed for the end of the third Five-Year Plan in 1966. He outlined the developments under his guidance on the beneficiation of manganese, chromite, graphite and pyrites, and the pilot-plant investigations on electrolytic manganese and manganese dioxide production. The importance of this work may be gauged from the fact that, next to the U.S.S.R., India ranks as the world's largest supplier of manganese ore. Hitherto, the major proportion has been exported and, while it is important that this should continue, it is equally necessary to refine the mineral in India, since the influx of foreign exchange would be instrumental in providing the means of purchasing capital equipment from abroad. A new process for the production of low-carbon ferrochrome by reducing chromite with ferro-silicon and aluminium has been successful, in addition to a method of making aluminium–silicon alloys by alumino-thermic reduction of quartz. Pilot-plant projects to be pursued during the second Five-Year Plan include the beneficiation of low-grade manganese and chromite ores, treatment of low-grade manganese, chrome and other Indian ores by ore-dressing methods and investigations into the manufacture of refractories. At present, work includes pilot-plant investigations into the value of oxygen in cupola practice and in the low-shaft furnace for the reduction of manganese and iron ores with non-coking coal; sintering or iron-ore flotation and magnetic separation of uranium-bearing copper tailings; sulphur production from low-grade pyrites and coal washery rejects; zirconium from Travan-

core beach sand; beryllium by an electrolytic process; titanium from ilmenite and rutile; ferro-chromium by means of an alumino-silico-thermal reduction method; and finally, the reduction of iron ore to produce a usable steel.

A most informative and interesting paper was given by Sir Charles Goodeve on sintering methods, which was followed by a paper on the "Efficiency of the Blast Furnace", by J. S. Vatchagandhy, S. Viswanathan and Dr. V. G. Paranjpe, of Tata Iron and Steel Co., Ltd. The material balance of an iron blast-furnace and an analysis of the effect of raw material changes on coke and flux requirements were discussed. The influence of chemical and thermal requirements on rate of use of coke, and the effect of high top pressure, sinter and oxygen enrichment on carbon efficiency were commented on. Comparison was made with the efficiency of the low-shaft blast furnace and direct reduction processes.

The pyro-metallurgical beneficiation of low-grade chrome ores was the subject of a paper by N. J. Wadia (Tata Iron and Steel Co., Ltd.). A method comprising the pre-treatment of high iron-content chrome ores under a reducing atmosphere at 550° C., followed by magnetic separation, yielded a concentrate containing 37·8–38·9 per cent chromium and had a Cr : Fe ratio of 3·02–3·09.

Dr. R. Krishnaswany (Atomic Energy Establishment, Bombay) outlined a method of separating leucoxene from rutile for the manufacture of titanium. Leucoxene is an oxidation product of ilmenite and is associated with free ferric oxide; thus the magnetic properties can be improved by a reduction roast with carbon at 600/700° C. and magnetic separation achieved.

The problems associated with the reduction of titania and the possibility of using vapour-phase reaction of magnesium and titanium tetrachloride were discussed in a paper by Mr. P. P. Bhatnagar and Dr. T. Banerjee, of the National Metallurgical Laboratory, while Dr. H. N. Sinha and Prof. D. Swarup, of Banaras Hindu University, presented a paper on the "Electrolytic Production of Titanium".

Aluminium manufacture from bauxite by the Bayer process was covered in two papers by Dr. M. S. Thaker and Mr. V. V. Shah, of the Indian Aluminium Co., Ltd. Dr. E. G. Ramachandran (National Metallurgical Laboratory) presented an interesting paper on investigations carried out to determine the optimum conditions for the electrolysis of fused anhydrous aluminium chloride to yield aluminium metal and the optimum conditions for the chlorination of the ferruginous bauxite from the Salem district of Southern India. The object of the latter research was to eliminate selectively the main impurities to yield an acceptable grade of bauxite. The electrolysis experiments using pure salts and a container of nickel or graphite serving as a cathode and an anode of hard carbon or graphite, showed a current efficiency of 80 per cent and a product of 99 per cent purity. The chlorination tests on sulphided bauxite were encouraging, using a mixture of powdered bauxite and charcoal. 93 per cent iron oxide and 56 per cent titania were removed with negligible loss of alumina.

The extraction of uranium and thorium were considered by Prof. Brahm Prakash, of the Indian Institute of Science, Bangalore, in a paper entitled "Extraction of Uranium and Thorium and Pyro-Metallurgical Processing of Reactor Fuel and Blanket Materials".

Dr. Indra Sanghi, of the Central Electro-Chemical Research Institute, Karaikudi, on the subject of "A Method of Electrolytic Extraction of Zinc from Low-grade Ores", outlined a method suggested as a result of a study of electro-deposition of zinc from alkaline zincate solutions. The practical and theoretical aspects were discussed. Practical papers on the manufacture of zinc were presented by Mr. C. W. Thomas (Zinc Corporation, Australia) and Mr. S. N. Mukherjee (Metal Corporation of India, Ltd.).

The processes employed at the Tundoo Mines of the Metal Corporation of India, Ltd., to refine silver-bearing lead ores were described by J. H. Mackertoom; and lead extraction and refining in Australia were adequately dealt with by F. A. Green, of the Broken Hill Associated Smelters Pty., Ltd., Australia.

An important paper entitled "Sintering of Iron Ore Fines with Particular Reference to the Raw Materials for the Bhilai Steel Plant" was by G. P. Mathur, G. V. Subramanya and P. I. A. Narayanan. The effects of coke, moisture in the mix, basicity and raw materials proportions on the sinter time and quality have been studied in a pilot plant. Coke was shown to have a pronounced effect on sinter properties, and moisture affected permeability and sinter rate.

The symposium was very well attended by representatives from all over India and provided a vital link between the research work at the National Metallurgical Laboratory on one hand and the field workers and practical works' technicians on the other.

J. L. Harrison

OBITUARY

Prof. Joseph W. Kennedy

Joseph William Kennedy, chairman of the Department of Chemistry at Washington University (St. Louis), died in his home at suburban Ladue in St. Louis on May 5. He was born in Nacogdoches, Texas, on May 30, 1916, the son of Joseph William and Mattie Baxter (Wade) Kennedy. He graduated from Stephen F. Austin State Teachers College in 1935, and after receiving his master's degree from the University of Kansas in 1937 he obtained his Ph.D. in chemistry at the University of California at Berkeley in 1939. He left his position on the faculty of the University of California to lead the Chemistry and Metallurgy Division at Los Alamos during the Second World War (for which he was awarded the Medal of Merit in 1946) and has served as professor of chemistry and head of the department at Washington University since 1946.

Joseph Kennedy was considered by all of us who had the good fortune to know him well to be one of the most brilliant of scientists. He was one of the world's outstanding nuclear chemists, as well as one of the pioneers in this area of investigation. His book with G. Friedlander, "Nuclear and Radiochemistry", which is authoritative, complete and very well

written, and certainly the outstanding text-book in the field, is being widely used in universities and colleges throughout the world.

He has a number of outstanding research accomplishments to his credit, but perhaps chief among these is his work on plutonium. He participated in the discovery of plutonium and of the isotope plutonium-239, including the demonstration of its important property of undergoing fission with slow neutrons, at the University of California during 1940 and 1941. He played a leading part in these discoveries and in the early crucial study of the chemical properties which formed the basis for the chemical extraction process used in the manufacture of plutonium during the War. In recognition of the fact that these important discoveries were made before the time of government support of research toward the goal of quantity production of plutonium, he received, two years ago, together with his co-workers, an award from the United States Government through the Atomic Energy Commission. As head of the Chemistry–Metallurgy Division at Los Alamos he had a decisive role in the important chemical and metallurgical work which was carried out in connexion with the nuclear weapon development programme.

His classic work on the chemical separation of a number of tellurium isomers was an outstanding contribution not only to the understanding of the isomers themselves but also to that of the mechanism of the chemical method of separating nuclear isomers. His more recent work has been in the general area of the application of radioactive tracers to problems in inorganic chemistry. Noteworthy here are his investigation and elucidation of a number of reaction mechanisms; he has also made important and unique contributions in the field of self-diffusion.

Joseph Kennedy had an engaging, warm personality, an alert and distinctive sense of humour which could not go unnoticed for long in any conversation, and a brilliance of intellect which was discernible almost immediately to anyone who met him. He was an excellent teacher at both the undergraduate and the graduate research-levels. He is survived by his wife, Adrienne, and by three children, his sons Joseph Wade and Burton Mack, and his daughter Jill.

GLENN T. SEABORG

NEWS and VIEWS

New Foreign Members of the Royal Society:

Prof. H. A. Bethe

PROF. HANS ALBRECHT BETHE, who has been elected a foreign member of the Royal Society, is a distinguished American theoretical physicist. Born in 1906, at Strassburg, he studied at Frankfurt and took his doctorate at Munich under Sommerfeld. He soon made notable contributions to the theory of Stark splitting in crystals, electron theory in metals, theory of energy loss of charged particles and in quantum electrodynamics. The Bethe–Heitler formula for bremsradiation, the Bethe–Peierls theory of photo-effect of the deuteron and a theory of order–disorder phenomena in alloys date from visits of Bethe to Cambridge and Bristol between 1930 and 1935. Since 1937, Bethe has been professor of physics in Cornell University, where he has made fundamental contributions to the theory of nuclear energy production in stars, treating both the carbon cycle and deuteron fusion. He served as chief of the Theoretical Division at Los Alamos during 1943–46, and has played an active part as a post-war consultant to the United States Atomic Energy Commission. In 1947 Bethe successfully applied the idea of mass re-normalization in quantum electrodynamics to the explanation of the Lamb–Retherford shift of hydrogen energy-levels. Other major researches include theories of meson and nuclear scattering, meson field theory, shock waves, electromagnetic diffraction, etc. Bethe is a member of the U.S. National Academy of Sciences and has received its Draper Medal. He also holds the United States Medal of Merit; and was president of the American Physical Society in 1954. One of Bethe's major contributions to science has been the writing of superb review articles or books on the theory of metals, quantum mechanics of atomic systems, nuclear physics and field theory. These have been extremely useful to students and research workers in these fields.

Prof. A. Frey-Wyssling

BOTANISTS the world over will applaud the inclusion by the Royal Society of London of the name of Prof. Albert Frey-Wyssling in its roll of foreign members. Frey-Wyssling has won international fame through his work on the fine structure of protoplasm and its derivatives, and his books have for many years formed a valuable addition to the literature in this field. As professor of botany in the Pflanzenphysiologisches Institut of the Eidgenössische Technische Hochschule in Zurich, he follows a line of equally distinguished predecessors, including Carl Nägeli and H. Ambronn. With the exception of two years around 1930, which he spent in Java investigating the physiology of latex production in *Hevea*, Frey-Wyssling has spent his working life on submicroscopic histology. During his earlier years he was associated with Ambronn in the development of the polarizing microscope as a tool for the investigation of structure in biological material, and he played a large part in the development of polarization studies in this field. In the following years, using the polarizing microscope as an exact tool in research, he laid out for the first time the general plan of submicroscopic structure in many cell types. He later added the methods of X-ray diffraction analysis and most recently of electron microscopy. He has throughout shown a remarkable ability to select the relevant pieces of evidence from a wide variety of regimes in plant science, in the formulation of structure in terms of function; and the brilliance of his extrapolation from the earlier methods to structures then invisible but since confirmed in the electron microscope has been widely recognized. A recent article by Prof. Frey-Wyssling on "Macromolecules in Cell Structure" appeared in *Nature* of May 11, p. 941. Much of Frey-Wyssling's work is summarized in his books, and it is a testimony to his life's work that there must be few departments of botany throughout the world in which his books are not in constant use.

Prof. Otto Hahn

Prof. Otto Hahn has been elected a foreign member of the Royal Society. Prof. Hahn's career has been rather unusual. We are familiar with biographies of men who at an early age achieved some outstanding success to which their later lives added little. To Hahn it was given, by indefatigable work in the new science of radiochemistry, to build up a splendid reputation as the discoverer of radiothorium, radioactinium, the two mesothoriums, uranium-*Z* and—in collaboration with Lise Meitner—of protactinium; and then, in 1938 (in his sixtieth year), to astonish the world by the most important of all his scientific contributions, the demonstration of the fission of uranium under the impact of neutrons. This discovery did not fall to his lot by chance; it could only have been made in a laboratory where the analytical chemistry of the radioelements had been brought to such perfection that it could proceed undisturbed by the too narrow conceptions of contemporary physics. Thus, in spite of its revolutionary novelty, Hahn's crowning achievement was in a sense the fruit of all his previous labours. Hahn's devotion to science did not end there, nor with the shock he received in 1945 from the news that his discovery had led to the construction of bombs. After the collapse of Germany, when the very survival of German science was threatened, he gave up his cherished laboratory work, not in order to retire but to become president of the Max-Planck Society. He is still carrying the burden of this position, and there is a general consensus of opinion that no other man could have done so much to bridge the gap between the German scientists and their colleagues in other countries as Otto Hahn, whose political courage during Germany's darkest period had always been equal to his scientific eminence.

Prof. Arne Tiselius

Prof. Arne Tiselius, of the Biochemical Institute, Uppsala, Sweden, is well known in Britain, and his election as a foreign member of the Royal Society will give pleasure to his many friends. A pupil of The Svedberg, he applied himself to the development of methods of analysis and separation of macromolecular substances. The first success in this work was the Tiselius electrophoresis apparatus, which is almost a household word in all laboratories dealing with proteins and other macromolecular substances. It undoubtedly gave a great stimulus to the analysis of protein mixtures and is one of the most important tools in the field. Later he has developed preparative methods for the separation of such substances, including 'zone' electrophoresis and arrangements for continuous separation. He has also been greatly interested in the development of adsorption techniques for the separation of complex mixtures. He was awarded the Nobel Prize for Chemistry in 1948. In recent years he has been active in the international organization of science and was president of the International Union for Pure and Applied Chemistry, 1951–55, and is an honorary member of the scientific academies of numerous countries.

Metal Physics at the Royal Institution: Prof. R. King

In addition to the two Fullerian professorships of the Royal Institution (those of chemistry and physiology), to which appointment is made by the Managers, other chairs have been created from time to time, election to these being in the hands of members as a whole. In the past, and for varying periods, professorships of chemistry, mechanics, botany, natural history, natural philosophy and astronomy have been established. Most of these have now ceased, and at present the only one filled is that of astronomy, which was the last to be set up, in 1935. A new professorship in metal physics is now announced, and the assistant director of the Davy Faraday Laboratory of the Royal Institution, Dr. Ronald King, has been appointed to the post.

Dr. King graduated in physics from the University College of North Wales in 1936. After a period of teaching, he entered the Royal Aircraft Establishment, Farnborough, working first in the Armament Department and later in the Metallurgy Department, where he joined Dr. (now Prof.) Bruce Chalmers's very successful research group. In 1949 he went to University College, London, as a reader in metal physics, leaving in 1950 to take up his present post at the Royal Institution. The properties of grain boundaries, and the techniques and observations of thermal etching have formed Dr. King's main interests, and in 1955 he was awarded a Ph.D. degree for his work in these fields. At the Royal Institution he has necessarily broadened these interests in supervizing the various individual programmes of research workers and students. He has been a joint editor (with Prof. Bruce Chalmers) of "Progress in Metal Physics" since 1952.

Agricultural Research Council Adviser on Sheep Research

Prof. J. E. Nichols, professor of agriculture (animal husbandry) in the University College of Wales, Aberystwyth, has accepted an invitation from the Agricultural Research Council to be adviser on sheep research. Prof. Nichols's functions as adviser will be part-time: he will keep under review research in progress on sheep, and will be responsible for bringing to the Council's notice matters in this field which call for their attention, including the need for additional research.

Museum and Art Gallery, Durban

The annual report of the Durban Museum and Art Gallery for 1955–56 (pp. 19; 1957) stresses again the urgent need for new accommodation for both the Museum and Art Gallery. A site for these purposes has been allocated, and it is hoped that building operations will start in the near future. From the point of view of administration, much thought and attention have been given to strengthening the collections of the Art Gallery. In view of the fact that the establishment does not include a curator in art, the director of the South African National Gallery has been requested to appraise and report on the present status of the art collections. The constitution and membership of the Art Gallery advisory committee have also been recast.

Tetrahedron

The publication of the new quarterly journal, *Tetrahedron* (Vol. 1, Nos. 1/2; April 1957. Pp. 176. Subscription per volume (including postage): (*A*) £6 (U.S.A. 17 dollars); (*B*) for subscribers certifying that the journal is for their own personal use, £3 10*s*. (U.S.A. 9.80 dollars). London and New York: Pergamon Press, 1957), is the first truly international

journal of organic chemistry, and there can be no doubt that its success could make an important contribution to the generation of free and close contact between organic chemists throughout the world. That this objective can be achieved is indicated by the content of the first issue of 176 pages, which includes sixteen papers, two notes, and two preliminary communications. The origins of the papers are: U.S.S.R., four; Israel, three; Great Britain, three; and one each from South Africa, Japan, the United States of America and Hungary. Some of these papers do not differ in style from those which usually appear in the national journals, but it is hoped that authors will take advantage of encouragement by the editorial board to submit papers which also include a review of earlier work. This is very desirable because the reader can then appreciate more easily the importance and interest of the new results. The reviews by Prof. Fodor on "Recent Developments in the Synthesis and Stereochemistry of Tropane Alkaloids" and by Academician Nesmeyanov on the "Stereochemistry of Electrophilic and Homolytic Substitution at Olefinic Carbon" are timely and well illustrate how the international character of this journal may be expected to develop. Of the sixteen papers, two are in French, two are in German, and the rest are in English. The promise that future publications will contain papers based on researches which have already been described in other languages or in rather inaccessible journals is important. The quality of presentation of papers in *Tetrahedron* is excellent, and the reproduction of conformational diagrams and structural formulæ is very good, apart from those on pp. 28 and 29, containing oxygen atoms located near a six-membered ring, which are ambiguous.

Acta Embryologiae et Morphologiae Experimentalis

THE first number of a new journal, *Acta Embryologiae et Morphologiae Experimentalis* (Vol. 1, No. 1), appeared in February. It is published in Palermo under the editorship of D. A. Minganti, of the Department of Zoology of the University of Palermo, assisted by a committee of five, which includes members from that University and others from Milan and Rome. It is to be devoted, as the title implies, to papers on all aspects of experimental embryology and morphology. Papers are accepted in Italian, English, French and German, and, of the contributions in the present number, five are in Italian and five in English, each with a summary in the other language. With the exception of an account of a preliminary investigation of the succinic dehydrogenase and cytochrome oxidase in the sperm of sea urchins, the contents of the first issue are concerned with experimental investigations in the embryology and morphogenesis of various animals: chick, frog, toad, ascidians, sea urchins and *Aplysia*. The number contains 104 pages, about 9¼ in. × 6¾ in., and is well illustrated by a number of tables, graphs, line and half-tone blocks. The paper, printing and general lay-out are very good, and although all the authors are Italian, the papers in English contain few noticeable mistakes, albeit the phraseology is sometimes awkward. It is published by G. Denaro, Via Maqueda, 177, Palermo, and the price is 12 dollars per volume of approximately 300 pages, but no information is given as to how frequently numbers will appear. Editor and publisher are to be congratulated on the first number.

Forest Research in the Sudan, 1950–54

THE Sudanese Forestry Research Unit is attached to the Gezira Research Farm situated at Wad Medani, the headquarters of the Gezira Cotton Organization. In Memoirs of the Forestry Division No. 7 (Agric. Publ. Committee, Khartoum, 1956), forestry research in the Sudan for 1950–54 is discussed. The investigations carried out in the period are mostly of a preliminary nature, the result of the work of a sylviculturist and an entomologist. Experimental work with an irrigated plantation had been commenced by the agricultural research officers, with the object of supplying firewood to the large community connected with the Gezira operations, firewood being very scarce and expensive in the few heavily populated towns of the Sudan. The species *Eucalyptus microtheca* has been found most suitable to the heavy, cracking, waterlogging or droughty soils of the Gezira, as these conditions resemble those in its Australian habitat. Other species are also being tried. Investigations into plantation work in the southern Sudan have shown that the teak introduced there grows rapidly and the early thinnings provide the poles so greatly in demand. *Cassia siamea* and *Cedrela toona* are also giving good results. In the Bahr el Ghazal Province investigations into the regeneration of the valuable *Khaya senegalensis* are being carried out; a hitherto unknown disease infesting the terminal bud has caused difficulty which has still to be solved. In connexion with the gum *Acacia senegal*, which provides a considerable revenue, the report is disquieting and disappointing. The sylviculturist writes: "The tapping and collection of gum in Kordofan (one of the chief regions of collection) is and will remain a peasant industry". Gum is purely a forest product and the trained forestry expert could certainly improve both outturn and tapping methods if the whole of the business were placed in his hands.

Phosphate on Bellona Island

THE Government of the British Solomon Islands Protectorate announces that the island of Bellona has been reopened to prospecting with effect from April 29. Phosphate has been proved by the Geological Survey Department, but not in as great a quantity as had been hoped. Some samples taken during pitting operations are high grade, and would be suitable for the manufacture of superphosphates. Full information and details can be obtained from the Senior Geologist, Geological Survey Department, Honiara, British Solomon Islands.

Meteorological Aspects of Atomic Energy

THE Executive Committee of the World Meteorological Organization decided, at its meeting in April 1956, that the Organization should advise its members and other international organizations on the meteorological aspects of the peaceful uses of atomic energy, and proceeded to set up a panel of four experts to study the matter. The results of the first year's work on the subject are described by the secretary-general, Mr. D. A. Davies, in the Organization's *Bulletin* for April 1957. The panel has pointed out that since modern instruments permit the detection of radioactivity even when present in minute concentrations, small quantities of a suitable radioactive tracer could be used for studying the large-scale air movements associated with the general circulation of the atmosphere. Other meteorological

applications of radioactive techniques that seem promising are the estimation of the water equivalent of deep snow by measuring the attenuation of radiation transmitted through the snow from a radioactive source immediately beneath it, the measurement of the water content of the soil by neutron absorption, and the use of natural radioactive substances produced by cosmic rays to investigate vertical diffusion and the rate of increase of carbon dioxide in the atmosphere. These subjects will be further considered by the Commission for Aerology of the World Meteorological Organization, which will meet in June 1957. As regards the assistance which meteorology can give in the use of atomic energy, the panel considered the meteorological conditions which influence the dispersal of radioactive effluents released into the atmosphere and which must be taken into account in siting and operating atomic power stations, and also considered the relationship between meteorological conditions and measured concentrations of atmospheric radioactivity. Plans were made to prepare a technical note on the subject and to maintain an up-to-date bibliography.

The Radio Source in the Direction of the Galactic Centre

A PAPER with this title, recently published by F. G. Smith, P. A. Brien and J. E. Baldwin, of the Cavendish Laboratory, Cambridge (*Mon. Not. Roy. Astro. Soc.*, **116**, 3; 1956), describes the results of their research on the radio source *IAU* 17*S*2*A* in Sagittarius, close to the direction of the galactic centre. In spite of the fact that this radio source is one of the most intense in the sky, it has not been easy to observe owing to its peculiar location in the intense band of radiation from the galactic plane. It has been difficult to resolve both this band and also the source, using the aerial beam-widths that have previously been available, and the present paper describes the results of using aerials with high resolving power in the east–west direction at frequencies between 38 and 500 Mc./s. Within that range of frequencies it is found that the flux density increases with decreasing frequency, and the brightness temperatures exceeded those expected from H(ii) regions. It is suggested that in this direction there is a non-thermal source of radio waves lying behind ionized hydrogen and that this source is situated in the nucleus of the Galaxy. The size of this source would be about 150 parsecs by 400 parsecs, the longer dimension lying in the plane of the Galaxy. While nuclei of dimensions as small as 20 parsecs have been observed in *Sc* galaxies, in which a high degree of turbulence has been apparent, no nuclei of such small dimensions as 150 parsecs have been reported from optical observations of *Sb* galaxies. Kwee, Muller and Westerhout have shown, however, that in our Galaxy large turbulent velocities exist in neutral hydrogen over a region several kiloparsecs across. It seems possible, therefore, that the discrete source represents a central condensation in this region.

Time Zones in the U.S.S.R.

NEW time zones, numbered from 2 to 12, have been officially established from March 1, 1957, on the territory of the U.S.S.R., to replace the zones fixed in 1919. These zones are in better agreement with administrative divisions, watersheds or river courses. An article by P. N. Dolgov (*Priroda*, No. 1, 57; 1957) includes a map of these new belts.

Capital for Scientific Development

AN inquiry has recently been carried out by the Science and Industry Committee of the Royal Society of Arts, the British Association for the Advancement of Science and the Nuffield Foundation into the possibility of speeding-up the application to industry of the results of scientific research. The report of the inquiry, by Prof. C. F. Carter, of the Department of Economics, The Queen's University, Belfast, and Prof. B. R. Williams, of the Department of Economics, University College of North Staffordshire, has been published by the Oxford University Press under the title "Industry and Technical Progress". The Royal Society of Arts and the British Association have arranged a conference to discuss two of the major aspects of this report. The conference will take the form of two one-day sessions, of which the first, to be held on June 27 at the rooms of the Royal Society of Arts, will deal with "Capital for Scientific Development: the Problems of its Supply for Industry"; while the second session, under the auspices of the British Association, will be held on July 5 at the University of Leeds (see *Nature* for June 1, p. 1112), and will concentrate on the supply of scientists and technologists for industry. Sir David Eccles, President of the Board of Trade, will open the Royal Society of Arts' part of the conference on June 27. The conference is open to all who are interested, without fee. Applications for tickets should be addressed to the Deputy Secretary, Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2.

University of Aberdeen: Blackwell Prize

THE University of Aberdeen will award in 1959 a Blackwell Prize; this was founded in 1793 by Mrs. Barbara Blackwell, widow of Thomas Blackwell, eleventh principal of Marischal College. The value of the Prize, which is open to unrestricted competition, is £60 for the best English essay on a prescribed subject and is awarded so far as possible every alternate year. The next award will be made in 1959 for an essay on "Francis Bacon and the Modern World". Essays should be 10,000–20,000 words in length, and must be lodged with the Secretary to the University on or before January 1, 1959. Each essay must bear a motto only and be accompanied by a sealed envelope bearing the same motto and containing the full name and address of the writer. Successful essays are placed in the University Library.

Oversea Service Division: Colonial Office

THE following appointments have recently been made in the Oversea Service Division, Colonial Office: M. A. G. Hanschell (development commissioner, St. Lucia), director of agriculture, British Honduras; T. H. Jones (assistant government chemist, Northern Nigeria), government chemist, Northern Nigeria; N. Kirby (government chemist, Jamaica), government chemist, Kenya; C. Boocock (geologist, Bechuanaland), director of Geological Surveys, Bechuanaland; J. W. Du Preez (assistant director of Geological Surveys, Federation of Nigeria), deputy director of Geological Surveys, Federation of Nigeria; G. Turner (meteorological assistant, Northern Rhodesia), technical officer, East African Meteorological Department, East Africa High Commission; D. E. MacGregor (principal veterinary officer, Northern Nigeria), chief veterinary officer

(Animal Industries), Northern Nigeria; C. D. Sutton, soil chemist, Sarawak; Dr. V. D. Van Someren, biologist, Kenya; B. Marshall, assistant government chemist, Federation of Nigeria; J. H. Hill, geologist, Fiji; G. Owen, veterinary officer, Nyasaland.

The appointment of P. W. Hanney was as entomologist, Northern Nigeria (and not Western Nigeria, as printed in *Nature*, May 4, p. 899).

University News: Birmingham

THE following appointments in the University of Birmingham have been announced: Dr. H. E. Daniels, to the newly established chair of statistics within the Department of Pure Mathematics, from October 1; Dr. S. R. M. Ellis, to the vacant chair within the Department of Chemical Engineering, from May 1; Dr. A. D. McQuillan, to the research chair in physical metallurgy, from October 1; Dr. C. Rainbow, formerly lecturer in the Department of Malting and Brewing and Applied Biochemistry, to be senior lecturer in charge of the Sub-Department of Malting and Brewing, from March 1; T. H. Richards, to be lecturer in civil engineering from September 1; W. G. Key, to be staff tutor in engineering production in the Institute for Engineering Production, from May 6; Dr. J. V. Whitworth, to be senior research fellow in pure mathematics, from October 1; C. D. Harbury, to be lecturer in economics, from October 1.

Bristol

THE following have been elected to readerships in the University of Bristol: Dr. W. Chester, in applied mathematics, and Dr. J. A. Laing, in veterinary science. The following appointments have also been made: Dr. D. J. Bohm, as research fellow in physics; A. J. B. Cruickshank, as research fellow in inorganic and physical chemistry; Elizabeth van Horn, as assistant bacteriologist; and K. W. Keohane, as lecturer in anatomy.

London

THE following appointments in the University of London are announced: Dr. A. W. Bishop, lecturer at the Imperial College of Science and Technology, to the University readership in soil mechanics tenable at that College; Dr. H. Halberstam, lecturer at the University of Exeter, to the University readership in mathematics tenable at the Royal Holloway College; Dr. M. J. H. Smith, senior lecturer in chemical pathology at King's College Hospital Medical School, to the University readership in chemical pathology tenable at that School. The title of reader in physics in the University has been conferred on Dr. E. H. Hutten in respect of his post at the Royal Holloway College.

Announcements

PROF. M. J. C. R. COURRIER, For.Mem.R.S., secretaire perpetuelle of the Paris Academy of Sciences, has been elected to a vacancy in the list of twenty-five Foreign Fellows of the Zoological Society of London.

M. EUGÈNE FREYSSINET, the eminent French engineer and inventor of prestressed concrete, has been awarded the Gold Medal of the Institution of Structural Engineers. The first paper on prestressed concrete to be read in Britain was given by M. Freyssinet, in 1936, on the occasion of a joint meeting of the Institution with the British Section of the Société des Ingénieurs Civils de France.

A MEETING of the Association of Clinical Biochemists (Southern Region) will be held at Addenbrooke's Hospital, Cambridge, on June 22 at 2 p.m. Those wishing to attend should notify Dr. N. R. Lawrie, Addenbrooke's Hospital, Cambridge, from whom further details can also be obtained.

A CONFERENCE on "The Rheology of Disperse Systems", organized by the British Society of Rheology, is to be held at the University of Swansea during September 19–20. Further details with regard to programme and accommodation in the University Hostel can be obtained from the conference secretary, Mr. C. C. Mills, Patra House, Randalls Road, Leatherhead, Surrey.

THE Production Engineering Department of the College of Technology, Birmingham, under the direction of Mr. T. B. Worth, is holding a full-time course of three weeks duration on "Statistical Quality Control and Acceptance Sampling", commencing on June 17. The course is primarily intended as an introduction to the subject. The first fortnight will be spent in covering the general principles and procedures involved. The final week will be devoted to lectures by specialists from industry, and to visiting the works of firms employing quality control where members of the course will be able to see the practical application of quality control methods and discuss the techniques and associated problems. The course will be directed by Dr. C. J. Anson, senior lecturer in the Mathematics Department, and Mr. J. D. Morrison, senior lecturer in the Production Engineering Department.

THE Royal Photographic Society of Great Britain (Scientific and Technical Group), in collaboration with the Department of Scientific and Industrial Research, is to hold a conference on "Industrial High Speed Photography" on June 21 at the Royal College of Science and Technology, Glasgow. Among the papers to be presented are an introductory talk by Mr. W. D. Chesterman, followed by a colour film on "Welding Problems"; "Electrical Research and Production Problems including Circuit Breaker Research", by Mr. Austin Young (Reyrolle, Ltd., Co. Durham); "Study of Cavitation", by Dr. I. S. Pearsall (East Kilbride, Glasgow); "Techniques for Kinematography of Combustion in Diesel Engines", by Mr. J. G. G. Hempson (Ricardo and Co., Ltd., Shoreham-by-Sea); "Application of High Speed Photography to Production Problems", by Mr. J. Hadland (John Hadland and Co., Chipperfield, Herts); "Simple Methods of Recording High Speed Events", by Dr. J. S. Courtney-Platt (Cambridge). All who are interested in this field are invited to attend. Detailed programmes and further information can be obtained from Mr. E. Martindale, Department of Scientific and Industrial Research, 20 Walker Street, Edinburgh 3; or Mr. R. E. Withrington, c/o Research Laboratory, Ilford, Ltd., Ilford, Essex.

ERRATUM. In the communication entitled "Depolymerization of Hyaluronic Acid by X-rays", by Dr. A. Caputo, in *Nature* of June 1, p. 1133, we regret to find that Fig. 2 has been displaced. The graph should be turned clockwise through 90°, the axes remaining as at present. Thus the lowest values of the sedimentation constant occur at the highest concentration of hyaluronic acid.

INDUSTRY AND THE TECHNICAL COLLEGES IN BRITAIN

SECOND NATIONAL CONFERENCE

TWO hundred delegates, mainly comprising principals from technical colleges, training officers from industry and leading industrialists, were present at a one-day conference organized by the Federation of British Industries at its London headquarters on Wednesday, May 15.

The central feature of the conference was an explanation by Dr. Willis Jackson of the report of the Committee on Recruitment and Training of Teachers for Technical Colleges which was appointed by the Minister of Education last September. Dr. Jackson, chairman of the Committee, explained how the recommendations were based directly on the objectives set out in the Government White Paper on Technological Education, which called for an increase in the number of technical college places for sandwich-course students from 9,500 in 1956 to 15,000 in 1960, together with expansion of part-time day-release facilities from 355,000 in 1956 to approximately double this number. There are approximately 11,000 full-time and 40,000 part-time teachers in technical colleges in Britain to-day: the Committee estimates that expansion during the next four years will require an additional 7,000 full-time teachers and 8,000 part-time teachers. These "disturbing figures" become even more disturbing when analysed in terms of subjects, for the requirements are greatest in mathematics, science and technology.

The current recruitment of mathematics and science graduates into technical colleges is mainly at the expense of other schools. Technology graduates can be drawn only from industry or government departments, as practical experience is essential for technological teaching. Industry must be willing to accept the transfer to full-time teaching of experienced staff it can ill afford to lose, and it must release staff for part-time teaching. The teaching requirements of the next few years cannot be met unless industry and the technical colleges establish a new working relationship, and it should become "a commonplace" for individuals to move from industry to teaching and back again.

Dr. Jackson said that the "kernel of the report" is a number of provisions aiming at making teaching as attractive as it should be. Local authorities should make full use of their discretion in the grading of posts and of their power to grant salary increments for industrial experience. Every effort should be made to reduce the excessive amount of actual teaching required of many teachers, highly qualified staff should be deployed mainly on advanced work, generous provision should be made for clerical, laboratory and research assistants and opportunities should be given for teachers to take part in research and remunerative consultant work.

Viscount Hailsham, Minister of Education, opening the conference, said that technical education in Britain is, at last, capturing the imagination of the public. This is a factor of great importance, for public opinion will demand that money should be made available for adequate expansion of the technical colleges. He considered that technical colleges should be run by independent bodies of governors—not by local authorities—and the governors should preserve academic freedom.

We cannot produce the technicians and technologists required by industry unless we improve the standard of general education in schools, for the first essential of a good technical education is a good general education. Technical education is, apart from the universities, the principal way in which young people continue their education after leaving school and, the higher the technical standard, the greater the need for a liberal content. In fitting people for responsible positions, aptitudes should be considered the means, not the end, for the top men in industry are the men with the widest intellectual background.

Referring to the Willis Jackson Report, Lord Hailsham said that no solution to the man-power problem will be found if this is left simply to the Government. The problem necessitates a two-way exchange of views between the Government and industry. "Teachers," he said, "are the seed corn of industry; if one ate the seed corn there would be no harvest."

Sir Harry Pilkington outlined the progress that has been made since the conference on technical colleges and industry which was arranged by the Federation of British Industries and took place at Ashorne Hill, in 1954. The need for technical education was obvious at that time, but subsequent developments have meant that however high sights were set then they need to be raised now. We are in a more technical world even than we were then; but it is not only the technical world, for the commercial world is going to be new, dominated by challenge, hope and vision, too.

The whole recasting of the pattern of technical education in Britain, as outlined in the epoch-making White Paper of fifteen months ago, stands out as a landmark and conforms with the views expressed at the 1954 conference. The general administrative system is right, but drastic changes are now under way in classifying colleges, thereby concentrating the really advanced work in a small number of selected colleges in a position to achieve the standard of a good honours degree. The first eight colleges for advanced technology have been designated, but industry has not, perhaps, wholly appreciated that the reasons for this number being so low is because high quality necessarily needs some degree of concentration of work. Sir Harry said he is personally glad that the Hives Council is taking a strong line in keeping up the quality; but industry, also, must realize the danger in getting too many courses and colleges recognized as qualifying for Hives awards.

The other important proposals in the White Paper—the increase in the scale of building and the increase in the number of students—should not be overlooked. The universities and the technical colleges are both to expand, so that engineers from both sources are to be doubled in number and improved in quality during the next fifteen to twenty years.

The Industrial Fund for the Advancement of Science Teaching in Public and Grammar Schools

which has raised, allocated and spent three million pounds, is an outstanding indication of the appreciation within industry of the need for more scientific training and more technical education. No praise can be too high for those who conceived the fund and for those who took the responsibility for its allocation and business-like administration.

Sir Harry concluded by outlining the more important factors that need attention during the next five years, and he elaborated on three of these. First, there arises the question of students' maintenance costs. Industry is beginning to see that investment in people is its most vital, rewarding and difficult investment. Industry, large or small, should not hesitate to pay for the training of those released for further education, and it should scorn to ask the Government or local authorities to undertake this responsibility. Trying to make the Government pay for the maintenance of released employees is the antithesis of the idea which actuated the Industrial Fund.

Secondly, it is now time to start thinking about what steps should be taken to implement the commercial aspects of the White Paper policy. Finally, much co-operation is required between colleges and industry in devising the right courses, planning the curriculum, selecting the students and arranging progressive programmes of works experience so that students may earn and learn at the same time.

The discussion following Sir Harry Pilkington's speech was mainly concerned with the speed of development compared with that on the Continent, and with policy concerning students' maintenance costs. Several speakers referred to the strikingly different system of apprenticeship training in the three important countries of the Western world. The large proportion of boys and girls in Britain who do not receive good apprenticeship training would do so, compulsorily, if they lived in Western Germany. References were made to the unsatisfactory position whereby finance is left largely to the whim of each firm; but this matter was not pursued as it is now under discussion between the Federation and the Ministry.

Dr. P. F. R. Venables, principal of Birmingham College of Technology, read a paper on the liberal content of technical education. The number of specialists in modern technological society is certain to increase, and these specialists will become increasingly important sections of the community. They will exercise a wider influence on the economic and social life of the country than their immediate specialization warrants and, by reason of their enhanced prestige, they will be expected to carry over their prestige into other often unrelated fields. A narrow specific training will not equip them to understand their own limitations, nor the inherent possibilities for good or ill in these circumstances. Increasing numbers of specialists will pass into management, and again the need will be for judgment and wisdom in human affairs, in addition to their primary function as specialists.

Dr. Venables suggested that the significance of education for these wider functions no longer needs justification in purely economic terms; but this does not imply that everyone is persuaded of this in rational terms, still less that there is the will to act upon it. There are other utilitarian reasons for a liberal education; but these are inverted evaluations, because the good which derives from an unstinted education is good in itself and not merely because it often turns out to be useful.

By the nature of its work and its relations with industry, technical education can easily become utilitarian in outlook. It is, therefore, necessary to think in terms of a liberal technical education and not of a narrow technical training. This educational process must have three characteristics: diversity of experience, subjects to be studied, disciplines to be mastered and methods to be employed; intensity of illumination of the student's mind and experience; timing of the phases of education in relation to the student's personal development.

The selection of general studies has been the cause of long-continuing debate, but there is now fairly general agreement that about one-fifth of the student's educational time should be set aside for this purpose. Dr. Venables suggested that, for full-time and sandwich courses, five hours a week should be devoted to general studies, and this time should be divided into three broad divisions: main-course work, elective subjects and special lectures. The main-course work would comprise human aspects of industrial administration, economics, history of science and technology and the social aspects of modern technological society. Elective subjects could consist of English literature, foundations of Western civilization, science in ancient Greece, music, psychology, languages for travel and the visual arts.

Dr. Venables's suggestions were confined to full-time and sandwich courses partly because time is available in the courses, and partly because the introduction of general subjects into part-time courses is much more difficult. Furthermore, our education is far too much dependent on part-time studies, and efforts should be made to ease this problem by extending full-time and sandwich facilities to craft levels.

Several speakers in the discussion referred to the way in which Dr. Venables had 'got down to brass tacks' by making suggestions on training and on the content of the curricula. It was felt that examinations in general subjects should not form a compulsory part of the training programme. The problem of the part-time student should not be considered with a defeatist attitude, for much could be done by treating existing subjects liberally. One speaker was concerned with the growing demands made by the professional institutions, while another pointed out that we must reconcile ourselves to the fact that general subjects cannot be included without reducing the time available for technical studies. It was pointed out that if schools were to insist on a broadly based leaving certificate, as is traditionally so in Scotland, there would be less need for liberalizing subjects in the technical course.

In his reply, Dr. Venables said that the neglect of the part-time student is not defeatist: the question is whether anything can be done at all under existing conditions. On the question of whether present-day schooling is adequate, there remains the problem of timing certain subjects in relation to the maturity of the student, so that adequate schooling does not remove the case for giving adequate facilities for liberal studies.

The afternoon session opened with a paper on "The Future of Professional Sandwich Courses" by Mr. A. A. Part, under-secretary, Ministry of Education, who commenced by bringing up to date the figures for sandwich courses. In England and Wales, there are one hundred and seventy-three sandwich

courses in operation, with approximately three thousand students taking part. The rapid recent growth of courses is shown by the fact that five hundred students completed sandwich courses last summer, whereas the intake last autumn was more than a thousand. There is, however, a long way to go, for the objective of the White Paper is to raise the three thousand to twenty thousand, with five thousand enrolling each year.

This renewal of interest on the part of industry in Britain in the sandwich course is a remarkable sign of the times, for such courses have been operating in a few colleges since the beginning of the century. Until the Second World War, industry was well served by the combination of degree men and men who managed to achieve professional status by evening study based on a Higher National Certificate. Industry has always valued the type of man who achieved qualifications the 'hard way'; but this is a wasteful method of producing a considerable proportion of technologists when the need is to raise to the technological level every person capable of achieving this end.

A great deal of work must be done on the integration of works training and college study-periods. Co-operation between industry and colleges is important in every branch of technical education, but for sandwich courses it is basic and it has to be of a particularly intimate kind. Both colleges and firms must be convinced they have worked out the type of scheme best suited to the circumstances. These considerations would cover the length of the course, the length of the sandwich period, selection, reporting procedures and the possibility of the doubling-up principle whereby students are 'paired', with alternately one at college while his partner is at the works.

Wastage during courses is a familiar feature of technical education. A high rate of wastage must be avoided in sandwich courses not only because failure to make the grade means inefficient use of students and staff, but also because it is bad for the student, educationally and psychologically. This problem could be solved by a rigorous selection policy, following the pattern of the university rather than the general technical college.

The grammar and secondary technical schools will provide the bulk of the sandwich-course entrants; but it should be remembered that one-quarter of successful candidates in Higher National Certificate examinations have come from secondary modern schools. The National Certificate route should be kept in mind, for it keeps open a path for the secondary modern school pupil. By providing a diversity of routes to high qualifications, sandwich courses play a vital part in the new pattern of educational opportunity.

A considerable part of the discussion was devoted to questions of finance, and it was clear that a definite policy is required in the form of a government lead. There were differences of opinion on the part that should be played by small firms. On one hand, it is very difficult for small firms to make the works periods progressive and worth while: on the other hand, large firms claim they are at saturation point in training for their own requirements, and they are unable to accept college-based students for practical training. The suggestion that small firms cannot afford the cost was contradicted by a speaker who pointed out that if a small firm accepted a number of apprentices bearing the same ratio to the number of employees as the large firm, the proportional cost would be approximately the same.

The problem presented by the contribution of small firms towards training was taken up by Sir Norman Kipping, director-general of the Federation of British Industries, in his summing up of the Conference. Sir Norman quoted figures which indicated the large proportion of the ten million people employed in the British Isles working for small firms. No less than four million people work either for themselves or in firms with less than one hundred employees. He did not agree with the complete rejection of the economic justification for liberal education and there is, in his mind, a fleeting doubt whether the injection of liberal subjects is right for all students. If the prime justification for liberalizing technical courses is to provide leaders of other men, he said, attention should be directed to the fact that relatively few technical men do lead at the present time in Great Britain.

MOLECULAR MECHANISM OF RATE PROCESSES IN SOLIDS

THE Faraday Society, at the invitation of, and in conjunction with, the Koninklijke Nederlandse Chemische Vereniging, held its first discussion meeting of 1957 at the Koninklijke Institut voor de Tropen, Amsterdam, during April 15–18. The meeting created a precedent in that it was the first to be held on the Continent, although the Society had collaborated with the Société de Chimie Physique in a discussion on surface chemistry at Bordeaux in October 1947, and had held a general discussion, in September 1952, at Toronto. The present meeting again emphasized how the Society endeavours to encourage international interest in its work, and indeed its success is exemplified by the appearance of papers from America, Australia, Germany, Holland, Italy, Sweden and Switzerland.

The general subject had been somewhat arbitrarily divided into three main sections: relaxation processes; and steady-state processes involving, and not involving, lattice re-arrangement. Practically all the time of the meeting was devoted to lively and critical discussion of the papers which had been pre-printed and circulated well ahead of the conference. Members were welcomed by Mr. R. P. Bell, president of the Faraday Society, who, with Prof. Gerding, president of the Royal Dutch Chemical Society, shared the duties of chairman.

Prof. C. J. F. Böttcher (Leyden) introduced the first section with a concise review on the general principles of relaxation processes, and this was followed with a contribution by Dr. H. C. Brinkman and F. Schwarz (T.N.O., Delft) in which they presented a theory of the non-linear relaxation of solids in terms of a diffusion process of molecular groups over potential barriers and discussed the merits and drawbacks of this new approach. The mechanisms by which dislocations cause energy losses, namely, by hysteresis, resonance and relaxation, were outlined by Dr. A. Seeger, H. Douth and F. Pfaff (Max-Planck Institute, Stuttgart), and results were reported of calculations of the rate and activation energy of the process in which the Bordoni relaxation peak was attributed to dislocations overcoming the Peierls stress by thermally activated kink formation. Dr. R. H. Cole and S. Havrilak (Brown

University) dealt with further work on dielectric relaxation in solid hydrogen halides, and stressed the importance of dipole interactions for the structure and rates of molecular orientation in the low-temperature phase. A similar study by Dr. J. S. Dryden and R. J. Meakin (National Standards Laboratory, Chippendale, New South Wales), on some alkali halides containing divalent cation impurity, showed that the activation energy from the lower frequency absorption is associated with the orientation of the dipole of the divalent cation, and with ion-vacancy aggregate. Their results were in agreement with those obtained from d.c. conductance, if correctly interpreted, and with the heights of the energy barrier theoretically obtained from the elastic constants of the crystal. The paper by Dr. H. Gränicher, C. Jaccard, P. Scherrer and S. Steinemann (Zurich) on the theory of the dynamic behaviour of ice, in which the polarization changes were ascribed to orientational defects and ionized states, provoked some stimulating discussion, particularly on the Pauling theoretical value for the zero-point entropy. The first section concluded with a contribution by Dr. J. Volger (Eindhoven) on the dielectric loss in insulators containing impurity and colour centres, in which relaxation times were associated with very small activation energies; these latter cannot be attributed to migration losses and merit further study.

A concise review by Prof. J. S. Koehler and F. Seitz (Illinois) on point, line and planar imperfections introduced the second section. Prof. F. G. Fumi and M. P. Tosti (Palermo) then reported on some calculations of the energies to form and move vacancies in sodium and potassium chlorides, and Dr. J. Crank (Courtaulds, Ltd., Maidenhead) discussed the definition, measurement and interpretation of diffusion coefficients in solids. A comparatively new aspect of diffusion theory, the correlation between consecutive jumps of the mobile carrier, was developed by K. Compaan and Dr. Y. Haven (Philips, Eindhoven), who showed that this effect alters the self-diffusion coefficient in certain circumstances, but does not affect the ionic conductance; there thus seems some hope of disentangling diffusion mechanism in ionic crystals in greater detail. A somewhat neglected approach—the theory and measurement of thermoelectric power of ionic crystals—was the subject of a paper by R. E. Howard (Oxford) and Dr. A. B. Lidiard (Harwell), and F. P. Clarke (Harwell) reviewed the production of defects by irradiation and the kinetics of their annealing. Prof. W. Jost and Dr. H. Oel (Göttingen) reported briefly on their work on the sintering processes in silver iodide, and Prof. F. C. Frank (Bristol) gave a clear account of the interaction of point defects with dislocations. He briefly surveyed the very interesting methods of decorating dislocations in alkali halides that are being developed by Dr. J. W. Mitchell and his colleagues at Bristol. A short, but stimulating, discussion by Prof. A. R. Ubbelohde (Imperial College, London) on abnormal *A* and *E* factors in solid processes encouraged a lively exchange of views—not all, it must be admitted, related to the main aspect of the paper.

The third section comprised a group of contributions on individual topics which were not too closely related, but Prof. J. H. de Boer (Staatsmijnen, Limburg), in his introductory address, did much to give coherence and greater breadth to this field of study. Two papers were concerned with allotropic transformation—that on tin by Prof. W. G. Burgers and Dr. L. J. Groen (Delft), in which they stressed the mechanistic and kinetic aspects, and the other on sulphur by C. Briske and Dr. N. H. Hartshorne (Leeds), who were largely concerned with orientational effects. The latter authors created great interest by their colour ciné-film that illustrated the various facets of the transformation. The two remaining contributions differed widely in subject-matter. Dr. F. C. Tompkins and Dr. D. A. Young (Imperial College, London) discussed the information provided by conductance and absorption spectra on the annealing and thermal decomposition of azide crystals, and Mrs. M. M. de Maine, Dr. A. G. Maddock and K. Taŭgbŏl (Cambridge) concluded the meeting with an account of their investigation on the kinetics of a radical recombination process following radiative thermal neutron capture.

In addition to the scientific activities, there were many social events, which had been arranged by the Nederlandse Chemische Vereniging. These included an official reception at the Rijksmuseum by the Burgomaster of Amsterdam, dinner at the Carlton Restaurant, a boat-trip through the canals and harbour of Amsterdam at the invitation of the Municipality, and a day excursion to the nature reservation, Hoge Veluwe, and its picture gallery. Both Societies should be congratulated on the high level of the scientific discussion and the excellent organization of the whole meeting. It is to be hoped that this will be the first of many meetings of the Faraday Society on the Continent.

F. C. Tompkins

BRITISH RAYON RESEARCH ASSOCIATION

OPEN DAYS

THE British Rayon Research Association held the second of its annual open days on May 9 and 10. More than 450 visitors attended on the first day, and between 300 and 350 on the second. All the work of the Association was shown, with the exception, because of the present patent position, of some of the developments of fluid bed technique applied to textile processes involving heat transfer. All the staff is now at Heald Green, Manchester, the premises at Barton Dock Road having been vacated. An additional technological building at Heald Green is being planned, and it is hoped that construction will start soon.

Work on the hot alkaline degradation of cellulose in the absence of oxygen has been continued. A detailed chemical analysis of the products of this degradation has been carried out. The main products are acidic, the amount of neutral products being very small. Eight of these acidic products have been identified, the major constituent being D-gluco*iso*-saccharinic acid. These products are formed by attack at the reducing end of the cellulose chains, but the mechanism of formation is certain only for *iso*saccharinic acid. Consideration is now being given to labelling specific carbon atom positions with carbon-14, in the first place in model compounds, and then in the cellulose molecule, in order to throw further light on the mechanism of degradation. Simultaneously with the degradation reaction, there is a 'stopping reaction' which renders the cellulose stable to alkali. It has been shown that this 'stopping

reaction' is a rearrangement of the cellulose-reducing end-group to a D-glucometasaccharinic acid.

As the degradation and 'stopping' reactions are distinct, there was the possibility that, if the 'stopping' reaction could be accelerated with respect to the degradation reaction, losses in the alkali-refining of cellulose from wood pulp could be reduced. Wood pulp contains, apart from α-cellulose, short-chain glucans and xylans. The short-chain glucans appear to be produced largely by acid hydrolysis in the treatment of wood, and to consist of short-chain celluloses. The cold concentrated alkali-refining process involves the solution of these short-chain celluloses without any significant degradation of the cellulose. The hot dilute alkali treatment degrades the hemicelluloses to smaller molecules, which are soluble in the dilute alkali. Since the degradation process applies also to the α-cellulose, and the mechanism is considered to be the same for both α-cellulose and the hemicelluloses, it appears that any change in the relative rates of the 'stopping' reaction and the degradation reaction would not lead to a more economic refining process. Some advantage would be obtained if the relative rate of degradation of the xylans could be increased, and this aspect is under examination.

Two of the Association's research fellows, working at Birmingham, are studying the isolation of enzymes which attack specific carbohydrates. A pure culture of an enzyme which attacks the 1 : 4 β-link in cellulose has been produced, but it has not yet been shown whether it attacks other carbohydrates. Similarly, an enzyme which degrades xylans but not cellulose has been isolated and purified. In parallel with this work, the photosynthesis of cellulose in flax seedlings is being studied by the use of carbon dioxide containing carbon-14. A chromatographic method of separating the various products has been developed, and it has been shown that labelled sugars and other intermediate products are produced within a fraction of a minute, and labelled cellulose within three minutes.

Continuation of the preliminary work to a study of the photosensitized oxidation of cellulose by gaseous oxygen in the presence of dye molecules has led to a good understanding of the kinetics of the photosensitized oxidation of primary alcohols, and this work is being extended to secondary alcohols, glycols and ethers. A more detailed investigation of the transient states of dye molecules has shown that the excited singlet state may be more important than the triplet state, in this type of reaction.

Measurements of strain birefringence are in progress on cellulose monofilaments under a range of humidity conditions, with a view to obtaining a better understanding of the structural changes which take place on straining. The method has been applied very successfully to amorphous polymers such as rubber, but is more difficult to apply to fibres which have both amorphous and crystalline regions. One line of attack is to study specially prepared cellulose monofilaments, for which as much information as possible on the nature of the crystalline and amorphous regions has been obtained by other methods, and to interpret the strain birefringence measurements in the light of this knowledge.

A theory of polymer solutions, based on the concept of a network of long-chain molecules in which the cross-links are continually breaking down, has been developed. This theory leads to relationships between the birefringence and the principal stresses in terms of the parameters defining the network. These relationships have been worked out for shear flow, and methods of measuring these principal stresses, in solutions of high polymers, devised. With these two types of work it is hoped to be able to develop the measurement of strain birefringence into a powerful tool for understanding the behaviour of textile fibres.

Experimental work has recently been started on the general problem of the physical properties of yarns and cords as a function of the twist introduced in manufacturing operations. A fundamental theory of yarn geometry has been developed to account for such geometrical properties as, for example, the changes in cord length during twisting.

As mentioned last year, a large technological programme on binary blends of viscose with other fibres has been carried out. This programme is practically complete and the Association is about to start on a programme of blends of wool with man-made fibres. Wool carding machinery has been installed and some pure wool yarns spun.

The blended yarn programme enabled the Association to learn how to achieve the best commercial standards in dyeing and now it is about to start an investigation of the physical causes of common dyeing faults such as rope markings and moire effects. The problem is essentially a study of what happens to a textile fabric in dyeing and an interpretation of these effects in terms of fibre and fabric properties.

Last year (see *Nature*, **177**, 1160; 1956) three main machinery developments were mentioned. The Stains direct spinner has been further investigated and some progress in producing viscose and nylon tows of suitable properties made. The new 3-over-4 draw frame, an integral part of the Association's conception of the measures necessary for the successful short processing of rayon, has been introduced into a number of mills. This has directed attention to the necessity for improving the gear trains, with respect to elimination of vibration, not only on draw frames but also on speed frames. Consequently, the Association is at present concentrating on this aspect.

The past year's work on fluid bed techniques has been spent in understanding in greater detail the physical operation of the fluid bed and overcoming the engineering difficulties in building a slack-dryer. By a suitable design of the bed the tension required to draw cloth through the bed has been very considerably reduced, to about 0·5 oz. per 1-in. width of cloth. Numerous other applications of the technique have been foreseen by textile manufacturers and manufacturers of textile machinery, and several of these applications should be in commercial operation, at least as prototypes, during the present year.

A number of new instruments, arising either from the Association's research programme or from members' requests, have been developed. A simple method of measuring continuously the mean warp tension in a loom is now undergoing tests in a number of weaving sheds, and should prove to be very useful in the controlled operation of looms. An ingenious method of counting the number of filaments in a fibre has also been developed for one of the members. In its present form it is suitable for fibres containing up to about one hundred continuous filaments.

The number of staff has changed little in the past year. The total is now 265, made up as follows: research staff, 86; laboratory and technological assistants, 75; engineering, drawing office and maintenance staff, 63; library and administrative staff, 41.

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES

ANNUAL CONGRESS, 1957

THE South-Eastern Union of Scientific Societies held its sixty-second annual congress in Hastings during April 25–28, under the presidency of the Astronomer Royal, Dr. R. v. d. R. Woolley. Throughout the congress an exhibition of archæological, botanical, zoological and general interest was on display at the White Rock Pavilion, including special exhibits by schools' science departments. A young naturalists' evening was arranged and attracted a record attendance of 350. Questions from the audience were answered by a panel of experts, and the lecture by [the late] Maxwell Knight on the hand-rearing of birds was illustrated by a film.

Dr. Woolley's presidential address to the Union was on "Large Telescopes". He began by speaking of the work done by the ancient Greeks without the aid of telescopes, of their attempt to measure the distance of the Sun, and also of the Moon by lunar parallax, mentioning the difficulty they experienced both of measuring and appreciating the necessary accuracy of the angles involved. He then outlined the establishment of the Royal Observatory at Greenwich in 1675 for "finding out the longitude of places for perfecting navigation and astronomy", at which Charles II appointed Flamsteed 'astronomical observator' with a salary of £100 a year, from which he was to pay for his instruments. The industrial development around the Observatory in the twentieth century obscured the sky with factory smoke and the city lights at night fogged the photographic plates, so that work at Greenwich could not continue. Herstmonceux Castle was chosen as the Royal Observatory's new home for, in addition to providing accommodation with an area of 400 acres, it had a maximum of sunshine, a clear sky, a free horizon and a stable sub-soil upon which to erect new buildings. Dr. Woolley spoke of the transfer of instruments from Greenwich and of the erection of the domes and installation of the telescopes in the new Equatorial Buildings. After giving details of the 200-in. telescope in the United States, he spoke of the new Newton telescope to be installed at Herstmonceux which, with its great 98-in. mirror, will enable a new study to be made of the extra-galactic nebulæ. He concluded by saying that, for a nation engaged in the new technological revolution, the study of astrophysics is a necessity and the large telescope an essential tool.

The presidential address to the Archæological Section was given by Mr. Manwaring Baines, who spoke on "The Life of the Poor in Eighteenth Century Hastings". He said that until 1753 each parish had to cope with its own poor. In the eighteenth century Hastings was in a bad way, the poor were extremely badly housed, out-relief was the common practice and parish officers had to collect as well as distribute funds. Later the parishes united and a common poor-house was built, a governor was appointed and those paupers able to work were called upon to assist in meeting the cost of their keep, while elementary education was given to the children by the governor's daughter. The conditions in the poor-house were insanitary, bugs were so prevalent that they were wrongly thought to be the cause of a smallpox epidemic; only two sparse meals were provided each day and the smallest misdemeanours were punished by flogging. More prosperous times had arrived by 1776 and the poor-house was closed.

Mr. D. Brightmore gave the presidential address to the Botanical Section, his subject being "Maritime Vegetation of the Rother Estuary". He spoke first of the salt marsh vegetation established on tidal zones of sand and mud behind shingle banks. Seeds carried in by the tide germinate and help to stabilize the silt. The water has a low mineral content, approximately 3 per cent, and the vegetation has a wide tolerance to salt. Mr. Brightmore spoke of the great variation of conditions, the submergence of the area at the equinoxes alternating with periods of drought. The plant habitats are also considerably altered by artificial drainage and grazing by animals.

Dr. J. F. Kirkaldy, as president of the Geological Section, dealt with "The Work of the Weald Research Committee". After outlining the work done by the early investigators, he spoke of the long time that elapsed before reconsideration was given to the subject. The Geological Survey had published several memoirs on the Wealden area, but owing to transport and other difficulties, much was written without the ground being revisited and the work could only be published at long intervals. During 1925 a committee was founded by the Geologists' Association to carry out a detailed investigation of the area. Amateurs and professionals worked together, relations with the Geological Survey were cordial and many detailed papers and large-scale maps prepared by the Committee have been published. Dr. Kirkaldy concluded with a description of the present stage of knowledge of the geology of the Weald as revealed by the researches of the committee.

Prof. J. Z. Young chose for the presidential address to the Zoological Section the subject of "Learning in the Octopus", and commenced by saying that memory could be described as stored-up evolutionary experiences related to what may happen in the future. It was necessary to use the terminology of the engineer to find terms to talk about these things. Prof. Young illustrated his lecture with graphs showing the reaction of the octopus to plaques of varied shapes, some providing food, others giving small electric shocks. Memory enabled the animals to correlate the experiences, approaching the shapes providing food and avoiding the others. When the visits were at five-minute intervals the responses showed quick assimilation by the memory of the experiences, but when the interval was increased to an hour there was a return to the original random behaviour. Nevertheless, memory enables the animal to be better able to do in the future what has been done in the past.

During the congress favourable weather conditions permitted the full programme of excursions to be carried out. The archæologists visited Pevensey, Battle Abbey and Great Dixter manor house, the botanists and zoologists going to Petts Level, Camber and Northiam. The geologists made excursions to Cliff End to collect fossil plant remains from the submerged forest and the Ashdown Sands, to Fairlight Glen and to East Hill Cliff for fossil fish remains. General excursions included a tour of the Old Town and visits to the Museum, Alexandra Park and greenhouses to view the summer bedding plants.

The success of the congress was ensured by the excellent management by the local honorary secretary, Mrs. K. N. Quarterman.

At the general assembly the importance was stressed of the work to be done by local societies in connexion with a conference to be held during April next year at the rooms of the Zoological Society on "Nature and Countryside", at which delegates from 150 societies will discuss conservation in south-east England. The sixty-third annual congress of the Union will be held during April 1958 in Reading.

F. J. Epps

MEAT HYGIENE

THIS monograph* was inspired by a seminar on "Meat Hygiene" organized by the World Health and the Food and Agriculture Organizations, and held in Copenhagen during February 1954. The names of the contributors—Albertsen, Benoit, Blom, Croft, Dolman, Drieux, Hood, Hothuis, Jepsen, Johansen, Kaplan, Koch, Scaccia-Scarafoni, Schmid, Schönberg and Thornton—not only show the truly international character of this work but also guarantee that the subject is adequately covered at the level of veterinary and medical science. The monograph is divided into sections on epidemiology, ante-mortem care, slaughter, post-mortem inspection, processing and marketing, training of personnel and meat hygiene practice. There are also some sixteen annexes on a wide variety of matters concerning meat and meat hygiene, together with a very useful bibliography. This book may be regarded as an up-to-date picture of our state of knowledge of meat hygiene, and of the risks to health by faulty hygiene under both primitive and civilized conditions. The risks implicit in primitive communities are easy to understand, but it is not generally realized that European communities are also vulnerable. In this connexion, attention is directed to the fact that large-scale handling of food, for example, school and canteen meals, presents formidable problems if food poisoning is to be avoided. The need for ante-mortem care of meat animals is emphasized, and ways in which the mechanics of loading and unloading animals into trucks and lorries can be improved are discussed. Ante-mortem inspection, so frequently neglected, is once more shown to be essential.

Perhaps the most topical section is that dealing with the design and operation of slaughter-houses. In Britain, the committee recently set up by the Government to report about the conditions in which live cattle are exported to the Continent was shocked to learn that contracts for the supply of meat for United States Forces in Europe could not be arranged from Britain direct because the hygienic standards of slaughter-houses in this country fell short of those demanded by the American Army Veterinary Corps. While this is not true of all our slaughter-houses, there is much to be learnt from the best ones in Europe.

Stunning (that is, making the animal completely unconscious) prior to slaughter is recommended. Among the methods described are the use of an electric current through the brain and of an atmosphere containing 60–75 per cent of carbon dioxide. With an electric current the voltage should be kept to 70–80 V. in order to avoid hæmorrhage of the lungs. Moreover, it is emphasized that care in the use of electrical apparatus is necessary—for example, it should be applied to the right part of the skull. The use of carbon dioxide has proved highly successful on the large scale with pigs, the animals becoming unconscious within fifteen seconds and remaining so for about a minute.

The rapid cooling of carcases is advocated on the grounds that bacterial growth is slowed down and the carcases lose less weight by the evaporation of water from their tissues. It is emphasized that the critical zone for the growth of bacteria is from 15° to 50° C. (59° to 122° F.) and that in handling meat and meat products the time spent in this range of temperature must at all costs be reduced to the essential minimum. This rule is just as important, hygienically, for cooked meat as for raw meat.

It is pointed out that meat hygiene cannot be the responsibility of veterinarians alone, but that teamwork between themselves, public health officers, epidemiologists, sanitary engineers, public health educators and private doctors is needed if meat hygiene is to be successful and prevent outbreaks of disease in meat-eating peoples. E. H. Callow

* World Health Organization. Monograph Series No. 33: Meat Hygiene. Contributed by V. E. Albertsen and 15 other authors. Pp. 527+2 plates. (Geneva: World Health Organization; London: H.M. Stationery Office, 1957.) 30 Swiss francs; 50s.; 10 dollars.

COLOMBO PLAN

REPORT FOR 1955–56

THE fifth annual report of the Consultative Committee for the Colombo Plan* covers the year 1955–56, during which economic indicators suggest that national incomes continued to rise at a rate slightly in excess of the rate of population growth. India's first Five Year Plan was completed with encouraging overall results, including a 35 per cent increase in the index of industrial production, and a second Five Year Plan, for 1956–61, has been adopted, while in Pakistan, where the index of industrial production increased by 23 per cent in 1955, a new draft Five Year Plan is being examined by the Central and Provincial Governments. Development programmes in Burma and the Philippines were adjusted, comprehensive plans for Indonesia and Nepal are under consideration, and a National Planning Council has been established in Ceylon. External economic assistance again played an important part, and besides the equivalent of some 975 million dollars of capital aid in the form of inter-government grants and loans made available by donor members outside the area in 1955–56, loans totalling 125 million dollars were made by the International Bank for Reconstruction, and members within the area assisted one another with some capital development funds and technical aid. The numbers of people undergoing technical training and of experts employed continued to expand: there are now almost 3,000 trainees from the area studying in all parts of the world and more than 2,000 experts from abroad working in the area. The report emphasizes, however, the necessity for arduous and skilful adminis-

* The Colombo Plan for Co-operative Economic Development in South and South-East Asia—Fifth Annual Report of the Consultative Committee. Pp. 155. (Cmnd. 50.) (London: H.M. Stationery Office, 1957.) 5s. 6d. net.

tration to ensure that the right sort of training is found for, or adapted to, the right sort of students, and that what is learnt is applied and passed on.

Technical assistance generally is reviewed in a separate chapter. Since 1950 technical assistance has been extended to about 11,000 trainees and about 4,000 experts have been provided, the figures under the Technical Co-operative Scheme in 1955–56 being 50 per cent higher than those for 1954–55. There has been some shift in emphasis towards engineering (particularly applied scientific research), while interest in agriculture, health and education continued and training periods tend to lengthen. Increasing use is being made of training facilities available in the region, and India has provided training facilities for 556 persons. In some fields contributions from teams of experts are becoming more frequent, and generally there is a marked emphasis in technology and industry on experts from outside the region. New ways by which technical assistance could be provided are being studied, and Australia has introduced a Correspondence Scholarship Scheme under the Colombo Plan. Much equipment has been provided for laboratories and training and research institutions and of the offers of equipment and spare parts to the value of £3 million made or under negotiation, £600,000 is for laboratory equipment, £1,300,000 for training purposes and £375,000 for research equipment.

Technical assistance continues to form a large part of United States aid to the countries of south and south-east Asia, for which more than 40 million dollars were made available in the year ending June 30, 1956, a major objective being the development of self-supporting educational and training facilities to the point where more and better training can be provided from the countries' own resources. Up to that date the United States Government technical co-operation programmes financed the training of nearly 4,000 persons and the provision of more than 1,200 United States experts in the countries concerned, as well as making available a wide range of demonstration and training equipment. Many contracts, usually for three years, have been concluded between universities in south and south-east Asian countries and those in the United States, covering assistance in improving curricula, provision of training facilities in United States universities and interchange of teaching staff.

The United States Government and its Specialized Agencies are another major source of technical assistance, and stress is laid on the value of the reports and economic surveys produced by these bodies. The United Kingdom is the principal source of technical assistance to Singapore, the Federation of Malaya, Sarawak and North Borneo, and bilateral technical assistance agreements have been made between certain Colombo Plan countries and countries which are not members of the Plan. To avoid overlapping and ensure that such assistance is, so far as possible, complementary, liaison officers are maintained with the Council for Technical Co-operation in Colombo by both the United States Government and the United Nations Technical Assistance Board.

A chapter of special interest in the report is that which reviews the tasks ahead. While much progress has been made in the economic growth of the region, there is an increasing awareness of the need for maintaining flexibility in furthering development programmes, while consolidating existing gains. The problem of developing sufficient opportunities for productivity employing the growing human resources of the area remains, while the varying stages and forms of development and the wide range of experience within the region provide new opportunities for co-operation among the countries of south and south-east Asia. Future development will tend to require more complex and difficult decisions in such matters as the extent to which the fruits of development can and should be devoted to consumption rather than investment, the pattern of investment, and the impact of a country's development programme upon its external situation and the economic life of other countries. The mobilization of additional departmental energies will be required in both the public and the private sectors, and while the flow of external resources to the countries in the region has so far been largely in the form of grants, increased opportunities may develop for drawing on foreign private investment and on private and public loans as sources of external capital. The record of achievement set forth in this report gives reason to believe that, however great may be the difficulties ahead, they will be overcome.

THE FUTURE OF REINDEER IN SCOTLAND

WHEN reindeer were introduced into Scotland some ten years ago, a significant factor was that the various ground, rock and tree lichens eaten by reindeer play little part in the diet of red deer, roe deer, sheep, or other indigenous animals. In places the lichens form a carpet several inches deep. It was this discovery of untouched lichens that gave rise to the reindeer experiment now proceeding in Scotland; its course has been described by N. N. P. Utsi (*Oryx*, **4**, No. 1; April 1957).

In northern Scandinavia there are more than 600,000 domesticated reindeer and in the northern U.S.S.R. approximately two million, valued for their meat, skins, milk and hair, and for transport. These benefits have led to imports of reindeer in Alaska, Canada and South Georgia. Usually described as an arctic animal, the reindeer is widely found in the sub-arctic and in zones regarded as 'temperate'.

There were many reindeer in Scotland in prehistoric times, and these were probably hunted with red deer. Why the wild reindeer died out while the red deer remained is unknown. Utsi suggests that reindeer meat was probably more popular, and the pre-firearm techniques of the chase were not adequate to eliminate the fleeter red deer.

Why should reindeer now be 'forced' to live in Scotland when they had once died out? There are a number of reasons. Good meat can more easily be obtained at the time it is wanted, and be carefully handled, when it comes from a tame or at least half-tame animal. Reindeer owners, whatever their language or origin, eat mainly or only reindeer meat; their farming neighbours often buy reindeer meat, in spite of owning meat-producing animals themselves. In the cities and towns of Scandinavia it is rated a delicatesse; the tender tongue is a delicacy in Europe. Reindeer hide also tans to a fine chamois-like surface suitable for ladies' gloves and handbags.

The leader of the experimental herd has now been in Scotland four and a half years. After setbacks on unsuitable land, the herd has been increasing since May 1955, through calves bred and born in the Cairngorms, and now numbers sixteen. When considering the future of reindeer in Scotland, it is recognized that there is some overlap between the pasture of reindeer, red deer and sheep. But, as there are areas in Scotland which are scarcely grazed by red deer or sheep and yet offer good reindeer pasture, this slight overlap would not justify the exclusion of reindeer.

RARER BIRDS OF PREY

BIRDS of prey always attract attention and arouse an unusual degree of admiration or persecution according to outlook. Largely for that reason, their distribution and their breeding-populations are often shrouded in secrecy. Indiscriminate disclosure which could lead to persecution or disturbance of hard-pressed species would be indefensible. Secrecy can be carried too far, however, and it is essential to both science and bird-protection that adequate records should be kept, and that information which cannot harm the birds should be shared. The editors of *British Birds* have, therefore, prepared an up-to-date account of British birds of prey, indicating those factors which have been working for and against the birds (**50**, No. 4; April 1957).

Over the past few years there has been an increase in the numbers of buzzards, kites, hen harriers, marsh harriers and, perhaps, golden eagles. The osprey may now be re-establishing itself, and the goshawk has returned after an absence of a century or two. In almost every case, however, the position to-day looks worse than it was a year or two ago. The buzzard received a severe setback during 1954–55 through the impact of myxomatosis, coupled with increased human persecution. The kite population has also been unsettled and reduced. The 1956 reports from Scotland indicate that the hen harrier fared badly on the mainland and in the Hebrides. The golden eagle also suffered from shooting, poisoning, eyrie-stoning and burning, and in 1956 a number of pairs were missing from regular haunts. The disturbance caused by human intervention during the osprey's attempted nesting last season is widely known. Marsh harriers failed almost entirely in 1956 in one of their three strongholds. No breeding record of the goshawk has been made in recent seasons. Of other birds of prey, the numbers of Montagu's harrier are perhaps about the same as before the War, or a little higher, although probably less than they were ten years ago; there is no evidence of change in the status of hobby or honey buzzard; the peregrine has made some recovery from war-time organized shootings.

It is hoped that the publication of the survey will lead to the filling in of a number of gaps in the available information by contributions from other ornithologists. It is also hoped that efforts will be made to review the food and economic status of birds of prey and to bring about a more scientific and modern attitude towards them. A special article on the buzzard is being prepared for a later issue of the journal.

A NEW ELECTRONIC DIGITAL COMPUTER

THE Metropolitan-Vickers Electrical Co., Ltd., which has for some years been engaged on basic developments for a variety of electronic computers, has recently announced the completed development of the first model of a new range, the 'Metrovick 950', which is a general-purpose electronic digital computer capable of application to a wide variety of mathematical problems in research and engineering design. The computer incorporates interesting features of modern technique including the use of printed wiring on the plug-in boards and the extensive use of transistors in place of thermionic valves.

The machine is basically a device which will do arithmetic at high speed under the control of instructions given to it by the operator. The problem to be solved must first be stated in mathematical terms, and then the process of solution must be reduced to a series of simple arithmetical operations which the machine will perform. The list of instructions, called the 'programme', causes the machine to perform the necessary operations and combines them in appropriate sequence. The five basic units of the computer consist of the input equipment, for feeding information into the machine; the store, for holding instructions and data; arithmetical circuits, for performing the calculations; output equipment, for giving the results; and a control unit, to co-ordinate the whole machine so that instructions are obeyed correctly and in the right order. The input of numerical data and the programme of instructions are coded into holes punched on a paper tape, which is fed into the computer and from there read off photoelectrically at a high speed of up to 200 characters per second. The numbers are punched in the tape as decimals, each digit being represented by a five-hole combination, and each instruction is coded as a combination of decimal digits which is punched into the tape in that form. The computer automatically converts the decimal form into a binary representation in which one number or instruction is normally represented by thirty-two binary digits, called a 'word'. The main store is a cylindrical drum coated with magnetic oxide, on which a total of 4,096 'words' are 'written' as magnetized spots on 128 separate circumferential tracks, and the mean access time to the location of any word on the drum is one-half of a revolution period, that is, ten milliseconds. In the circuits the numbers and instructions are represented by electrical impulses which occur in a regular series with a pulse or digit frequency of 75 kc./s. In addition to the main store there are several stores with capacities of one or two words, the 'registers', for use in the arithmetical unit. The registers take the form of regenerative tracks on the drum, and a further store holding eight words on a regenerative track is provided to enable instructions to be modified after they are taken from the main store and before they are obeyed. The arithmetical circuits, which use transistors, include an adder–subtractor unit and a multiplier. The output is by means of five-hole punched tape or a printed page, and the control unit, using transistor circuits, controls the sequence of operations and the flow of instructions and numbers in the computer. The basic timing of the computer is controlled by signals obtained from the tracks on the magnetic drum, thus synchronizing the computer with the drum.

The computer, which is housed in a steel frame of overall dimensions 14 ft. 5½ in. × 4 ft. 10 in. × 6 ft. 1½ in., is assembled in three units—the control desk, control and power supply rack, and computing rack—each of which is designed to pass through a standard doorway (2 ft. 6 in. × 6 ft. 6 in.). All the operator's controls are conveniently arranged on a panel with a desk table in front, and two cathode-ray monitors enable the contents of any track in the stores to be examined. A set of thirty-two keys is provided, which enable a number or an instruction to be set up, together with additional keys to place it in any register as required. The input tape reader and the output tape punch are on the control desk, and the output printer, connected to the computer by a multicore cable, is on a wheeled trolley which may be situated anywhere near the desk.

Because of the use of transistors and printed wiring, the Metrovick 950 has considerably reduced overall size and weight, is more reliable and consumes less power (3 kW.) than computers using conventional thermionic valves. The first computer of this type to be completed is now in use in Metropolitan-Vickers' Electronics Department where it was produced, and additional instruments are being built for use in the Company's Research Department at Trafford Park and in the Associated Electrical Industries Research Laboratories at Aldermaston, Berks. Full details of the Metrovick 950 are given in an illustrated brochure (Metropolitan-Vickers Electrical Co., Ltd., Special Publication No. 7655/1).

A METHOD FOR THE ESTIMATION OF THE INCREASE IN CONCENTRATION OF ADENOSINE DIPHOSPHATE IN MUSCLE SARCOSOMES FOLLOWING A CONTRACTION

By Prof. BRITTON CHANCE and Dr. C. M. CONNELLY*

Johnson Research Foundation, University of Pennsylvania, and Biophysics Department, Johns Hopkins University

THE stimulation of respiration of mitochondria or sarcosomes by the addition of adenosine diphosphate is accompanied by striking changes of the steady-state oxidation-reduction levels of several respiratory enzymes as recorded by a special double-beam spectrophotometer[1-3]. Intramitochondrial pyridine nucleotide, very nearly completely reduced in the resting state of the mitochondria, becomes considerably oxidized upon addition of an excess of phosphate or phosphate acceptor. In the course of preliminary studies of the respiratory enzymes of excised muscle, it was found that the steady-state oxidation of intramuscular pyridine nucleotide was increased by contraction of the muscle[3]. In this communication, we describe how these two independent observations lead us to a quantitative determination of the increment of adenosine diphosphate or inorganic phosphate concentration following a muscle twitch. The method has the following advantages: (*a*) observations are made on one intact muscle without the need to destroy the tissue or to rely on 'paired' muscles or to use a muscle of atypical properties; (*b*) the observations are based upon changes localized in the muscle sarcosomes which are in contact with the myofibrils (for a summary see ref. 4); (*c*) observations can be repeated a number of times on the same muscle; (*d*) the method has a sensitivity in terms of adenosine diphosphate equivalent to less than 0.001 μmol. per gm.; (*e*) the method has a response time of less than 0.1 sec.

Because of the great interest in the role of adenosine triphosphate in muscular contraction, several papers have appeared in which a pair of muscles, one of which has been stimulated, are plunged into a freezing bath and are then analysed chemically for changes of adenosine di- and tri-phosphate levels in the stimulated muscle[4-7]. Due to difficulties in obtaining exact pairs of muscles, of freezing rapidly, and of avoiding internal contractions during freezing, the results of such chemical studies have a relatively low sensitivity (±0·03 (ref. 5) to ±0·01 (refs. 6, 7) μmol. adenosine diphosphate/gm.). The conclusion is reached that no significant changes in the level of adenosine diphosphate occur during a muscle twitch at 0°[4] and that muscular contraction can occur without the decomposition of adenosine triphosphate[5] (cf. ref. 8). We find that adenosine diphosphate or inorganic phosphate arrives at the muscle sarcosomes during the twitch in amounts readily measurable by this new method.

Fig. 1 shows three galvanometer oscillograph recordings of the output of the double-beam spectrophotometer, adjusted to measure the change of absorption at 340 mμ relative to 386 mμ, the two wave-lengths being selected so as to give maximal response to the reduction of pyridine nucleotide and a considerable rejection of light-scattering effects[9]. A perfused frog sartorius muscle, held in a flow chamber, is under aerobic conditions in oxygen-saturated glucose–Ringer solution at 7°. In trace *A*, electrical stimulation at 1·0 times/sec. causes an abrupt decrease of absorbency at 340 mμ (relative to 386 mμ). Upon cessation of stimulation the trace slowly returns towards the original base-line. In trace *B*, no upward deflexion of the trace occurs in a muscle pre-treated with 10^{-5} *M* dinitrophenol. In trace *C* the twitches are spaced at 15-sec. intervals to show clearly the brief artefact due to the twitch and the absorbency decrease following it. The contribution of each one of the earlier twitches to the change of absorbency is clearly shown.

These changes of absorbency are attributed to the twitch oxidation of reduced pyridine nucleotide for the

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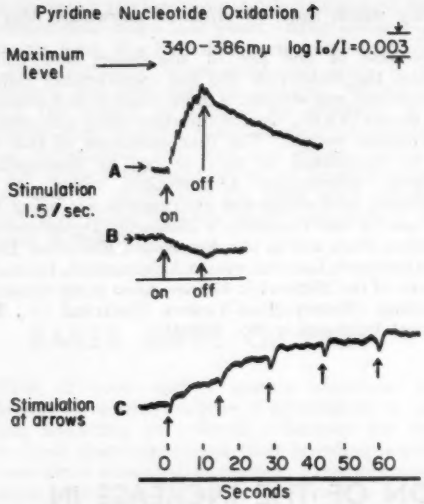

Fig. 1. Absorbency changes recorded in frog sartorius muscle 0·08 cm. thick upon contraction caused by electrical stimulation. The muscle was bathed in oxygenated Ringer solution at 7° and stimulated with silver electrodes (ref. 13). The time-scale applies to all three graphs, as does the absorbency scale. The recorder bandwidth is approximately 3·2 cycles per sec.
In traces *A* and *B*, stimulation is continuous from the point marked 'on' at 1·5 per sec. to the point marked 'off'. In trace *C*, stimulation occurs at 15-sec. intervals (exps. 301–3, 301–4, 303–3)

following reasons: (1) The absorption band of reduced pyridine nucleotide of the perfused sartorius muscle is clearly shown when the muscle is bathed in nitrogenated Ringer solution[3]. (2) Variations of the wave-length of the measuring beam in the vicinity of 340 mμ reveal that the decrease of absorbency caused by muscle contractions[3] has a maximum at 340 mμ. Evidence that we are dealing with pyridine nucleotide of the sarcosomes is afforded by the abolition of the change of absorbency by only 10 μ*M* dinitrophenol, a specific reagent for inhibition of this reaction in the sarcosomes.

Identification of adenosine diphosphate as the nucleotide that activates the sarcosomal pyridine nucleotide following the contraction is based upon the specificity of the respiratory chain for that substance[10,12,13]. The choice between adenosine diphosphate or inorganic phosphate as the activator is

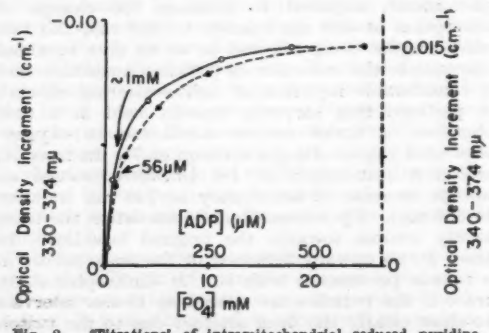

Fig. 2. 'Titrations' of intramitochondrial reduced pyridine nucleotide with phosphate (solid curve) or adenosine diphosphate (dashed curve). Additions of phosphate or phosphate acceptor are made to a suspension of rat liver mitochondria already supplied with substrate and oxygen. The decreases of absorbency due to the oxidation of reduced pyridine nucleotide are plotted, and the concentrations corresponding to half-maximal effect are indicated on the graph (Exps. 229*b* and 436)

made in favour of the former for two reasons. First, chemical observations show that very high phosphate concentrations are already present in muscle, and second, studies of other cells (baker's yeast and ascites tumour cells) show clearly that adenosine diphosphate and not phosphate is the activator of the resting state of metabolism, and it is reasonable to apply this result to the resting state of muscle. However, calculations are made for both adenosine diphosphate and phosphate. (Incidentally, we have been concerned to note the high levels of phosphate and adenosine diphosphate obtained by chemical analysis of mitochondria and of muscles that are presumably in the resting state[5,11]. The high affinity of the respiratory chain suggests that, were these enzyme systems actually in the resting state at the moment of termination of enzyme activity in the analytical procedure, the adenosine diphosphate values would be small compared to the 50 μmol. per litre indicated by Fig. 2. It is perhaps a problem for the biochemist to perfect methods for arresting metabolism without increasing the concentration of adenosine diphosphate.)

The concentrations of adenosine diphosphate and phosphate required to activate electron transport and to cause oxidation of reduced pyridine nucleotide in isolated mitochondria are shown in Fig. 2. In these experiments, solutions of adenosine diphosphate or phosphate are added to the mitochondrial suspensions and give the decreases of absorbency at 340 mμ with respect to 374 mμ as plotted in the graphs. Half-maximal effects are obtained with 56 μ*M* adenosine diphosphate and 1 m*M* phosphate, and similar values are obtained for heart muscle sarcosomes[12].

In Figs. 1*A* and 1*C*, the discussion above leads us to conclude that the same process is in progress: the contraction is causing increments of adenosine diphosphate or phosphate concentration to build up at the sarcosomes. At the end of the ten twitches, the level has built up to about three-quarters of the maximum level as obtained in a separate experiment similar to Fig. 1*A* in which the twitching was continued until a plateau was reached (see arrow). Half-maximal effect was obtained with seven twitches. By comparison with Fig. 2 the seven twitches have resulted in an increase of adenosine diphosphate concentration at the sarcosomes of 56 μ*M* (or 56 μmoles per kgm. wet-weight of muscle which equals 0·056 μmol. per gm.). In terms of phosphate, the value would be 1·0 μmol. per gm.

The average of the results of a large number of studies on the number of twitches required for half-maximal effect is 6, and this value is relatively constant in spite of wide variations in the rate of stimulation (see Table 1). Thus the value of adeno-

Table 1. Changes of Level of Reduced Pyridine Nucleotide following Muscle Twitches

Frog sartorius muscles, 5–7° in oxygenated Ringer solution plus glucose. Muscle essentially unloaded

Exp. No.	292*b*	292*b*	292*b*	301	301	301	301
Record No.	12	13	14	3	4	14	14
Stimulation rate (sec.⁻¹)	3	7	1·5	1·5	3	0·07	0·2
Total twitches	75	7	45	15	45	6	27
Maximal oxidation of reduced pyridine nucleotide observed (μ*M*) at given stimulation rate	24	14	23	25	32	11	30
Maximal effect with rapid stimulations (μ*M*)	24	24	24	32	32	32	—
Twitches to give half-maximal effect*	7	6	5	7	7	5	—

* We have computed the number of stimulations that have occurred in the time required for the optical change to reach half the 'maximal effect' with rapid stimulation. In 301–14 this point was reached by linear extrapolation from the initial increments per twitch. More refined calculations were not justified by the accuracy of the observations.

sine diphosphate per twitch is less than 0·056/6 ≈ 0·009 μmol. per gm. per twitch. The corresponding value for phosphate is less than 0·17.

It is unlikely that the spectroscopic method underestimates the adenosine diphosphate or phosphate concentrations; the sarcosomes are in direct contact with the myofibrils[4] and any change of concentration in the myofibril would be accurately measured by the sarcosome in contact with it. Re-synthesis of adenosine triphosphate within the myofibril is the only possibility for an under-estimation by our method, and the high affinity and reactivity of the respiratory chain for the diphosphate as well as the very high concentration of sarcosomes require such a reactive 'high-energy' store or transfer enzyme system as render this hypothesis very unlikely. In any event, an appreciable under-estimation due to re-synthesis by known stores of energy is very nearly ruled out by a consideration of the chemical results.

The uncertainties of the negative results obtained in three series of chemical analyses[5-7] are ±0·032, ±0·01 and roughly ±0·01 μmol. adenosine diphosphate/gm., as compared with our uncertainty of less than 0·001 and our actual assay of 0·009 μmol./gm. per twitch. The chemical results clearly limit the range of formation of adenosine diphosphate to the values we have found. The analytical results set similar bounds to our results when calculated in terms of inorganic phosphate; an uncertainty of ±0·39 of the chemical results is given[5] compared to our uncertainty of 0·02 and our actual assay of 0·17 μmol. phosphate per twitch.

In summary, this new spectroscopic method for a determination of the increment of concentration of adenosine diphosphate following a muscle twitch substantiates the result of the chemical studies that very little of the diphosphate is released following a muscle twitch, but our results go further and show how much adenosine diphosphate or phosphate is released.

These results may now be compared with the expected value for muscular contraction in an unloaded muscle. Values based on the assumption of 100 per cent efficiency of the biochemical process and calculated on the value of 12,000 cal. for ΔF for hydrolysis of adenosine triphosphate are 0·3 to 0·5 μmol. per gm. per twitch[8].

Our values are 2–3 per cent of the expected value calculated as adenosine diphosphate or 30–60 per cent calculated as inorganic phosphate. As discussed above, the figure for the diphosphate is probably the relevant one. On this basis, we can conclude that no significant portion of the expected breakdown product of adenosine triphosphate is found at the surface of the myofibril following a single twitch of an intact muscle. This result favours the idea that adenosine triphosphate need not be broken down during the contraction phase of muscle activity.

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AROMATICITY AND COLOUR OF COAL

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MANY physical and chemical investigations of the structure of coal over a period of years have indicated that coals consist mainly of polynuclear condensed aromatic structures. One interpretation of infra-red spectra and of some chemical studies on bituminous coals has questioned the presence of such structures in any appreciable quantities[1].

Spectral measurements in the ultra-violet and visible regions have been made on Pittsburgh vitrain (84 per cent carbon) in an attempt to measure possible concentrations of polynuclear condensed aromatics. Spectra of thin sections in the visible region, and of potassium bromide pellets in the ultra-violet region, show that absorption increases gradually from the edge of the infra-red through the visible and through the near ultra-violet region to 2100 A. No spectral band structure appears except for one broad band shoulder near 2650 A. which is typical of low-temperature chars and of strongly oxidized aliphatic substances[2].

Quantitative measurements in the visible spectrum and semi-quantitative measurements in the ultra-violet spectrum have been made in order to determine absorption intensities (specific extinction coefficients, K)[3]. The K values for Pittsburgh vitrain at two wave-lengths are compared with the K values of the principal absorption bands of various polynuclear condensed aromatics and of conjugated polyenes in Table 1. One of the absorption bands of violanthrene, a highly coloured polynuclear condensed aromatic compound, has a K value of 200 at 4920 A.; at the same wave-length Pittsburgh vitrain has a K value of 5·6. In the unlikely case that all absorption intensity of Pittsburgh vitrain at 4920 A. is due to violanthrene, the maximum possible amount of violanthrene nuclei would be about 2·8 per cent. A comparison of areas under absorption curves would permit a somewhat greater total concentration of polynuclear condensed aromatics, as various polynuclears absorb in different regions of the spectrum. But such a proposal is countered by the absence of the spectral structure that should result from a large concentration of various polynuclears. The most important limitation is the absorption intensity, which is too low in bituminous coals to substantiate

Table 1. Intensities of Principal Absorption Bands of Various Polynuclears and of Conjugated Polyenes; Comparison with Intensities of Bituminous Vitrain

	λ in A.	Specific extinction coefficient, K, in l./gm.-cm.
Coal: 84 per cent carbon vitrain, Pittsburgh seam	4000	10·0
	4920	5·6
Compound:		
Violanthrene*	4920	200
Anthanthrene*	4330	289
Dibenzo [a,i] pyrene*	3970	295
Dibenzo [a,h] pyrene*	3135	561
Coronene*	3018	771
Fluorenone†	2574	498
Anthracene†	2534	1,160
Phenanthrene†	2520	393
Naphthalene†	2220	762
Octatrienol‡	2650	434
Decatetraenol‡	2990, 3110	432

* Clar, E., "Aromatische Kohlenwasserstoffe", 2nd edition (Springer-Verlag, Berlin, 1952).

† Friedel, R. A., and Orchin, M., "Ultraviolet Spectra of Aromatic Compounds" (John Wiley and Sons, New York, 1951).

‡ Braude, E. A., Chem. Soc. Ann. Rep., **42**, 105 (1945).

high concentrations of polynuclear condensed aromatics or of conjugated polyenes.

The weak colour intensity of bituminous coals is also shown by the absorption index, 0·025 at 5460 A., calculated from absorption measurements on thin sections of Pittsburgh vitrain. Higher values obtained by Huntjens and Van Krevelen[3] for a powdered sample of Pittsburgh vitrain and a thin section of Velsen vitrain are given in Table 2. Absorption indices calculated by various workers from reflectance measurements are appreciably higher than 0·025 [3-6]. This discrepancy is presumably due to the fact that the reflectance equation is practically insensitive to absorption indices in the range of 0·025.

The colour of coal is not logically attributable to small amounts of polynuclear condensed aromatics since, as Hirsch has stated, polynuclears of the sizes indicated by X-ray measurements do not possess the colour of coal[7]. The colour of coal may be attributable to the structures with unpaired electron spins, presumably free radicals, shown to be in coal by paramagnetic resonance measurements[8,9]. These structures are apparently free radicals rather than solid-state colour centres, since solutions of asphaltene from coal hydrogenation[10] and coal extracts[11,12] produce similar paramagnetic resonance signals.

Free radicals absorb radiation over wide wave-length ranges[13], as does coal, and in some cases free radical spectra also are devoid of spectral structure[14]. Free radicals constitute only a fractional percentage of the coal[5,6] and their structures are unknown; they might be polynuclear condensed aryl radicals, semi-quinones[15], triarylmethyls, etc. It is possible that the dark colours of many different reaction residues with non-specific absorption spectra might be due to free radicals.

If the colour of coal is due to free radicals, the visible and ultra-violet absorption intensity should increase quantitatively with the number of free radicals. The existence of such a correlation would not constitute proof; but absence of any correlation would nullify the hypothesis. A preliminary correlation has been sought for free radicals and absorption intensity in high-volatile bituminous vitrain and lignite vitrain. Ratios of the specific extinction coefficients at three wave-lengths are compared in Table 3 with the ratio from Ingram's values for concentrations of free radicals in coals of 84 per cent carbon[16] and 72 per cent carbon[12]. These incomplete results do not include ultra-violet measurements. The trend shown by increasing ratios of coefficients with decreasing wave-lengths in the visible spectrum indicate that the ultra-violet intensity ratios may approximate the free radical ratio.

Table 2. Absorption Indices of Vitrains at 5460 A., determined by Absorption Measurements

	This work	Huntjens and Van Krevelen (ref. 3)
Pittsburgh vitrain	0·025	0·06
Velsen vitrain		0·04

Table 3. Correlation of Colour Intensity and Free-Radical Content of 84 per cent Carbon and 72 per cent Carbon Vitrain Thin Sections

	Specific extinction coefficient K in l./gm.-cm.			Free radicals per gm.
	7000 A.	5460 A.	4000 A.	
Pittsburgh vitrain (84 per cent carbon)	1·22	3·8	10	$0·50 \times 10^{19}$ (ref. 16)
Velva lignite vitrain (72 per cent carbon)	1·25	2·6	6·1	$0·12 \times 10^{19}$ (ref. 12)
Ratio	1·0	1·5	1·7	4·2

Other optical properties of coal, such as reflectance and refraction, have indicated that coal is composed principally of polynuclear condensed aromatics[17]. However, indices of refraction and absorption for coal might be explainable by small concentrations of free radicals as satisfactorily as by large concentrations of polynuclear condensed aromatics.

Charge transfer complexes may contribute to the colour of coal. Possible examples are complexes between quinones and hydroquinones[18], and between molecular oxygen and aromatic nuclei[19]. Some properties of charge transfer complexes do not exclude them, but neither do these properties indicate that complexes are causes of the colour of coal: (1) most known complexes are diamagnetic, whereas coal is paramagnetic; (2) solutions of complexes are electrical conductors[18], whereas coals have very low conductivities; (3) the optical properties of solutions of coal hydrogenation products differ from those of charge-transfer complexes[3].

The assistance of J. A. Queiser is gratefully acknowledged.

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LETTERS TO THE EDITORS

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Endoradiosonde

An arrangement that could send out information about conditions inside a living person could supply scientific information and also become a diagnostic tool in clinical work. For this purpose one would desire a radio method that could perform under approximately physiological conditions. Accordingly, we have produced a small capsule that a person can swallow, and which contains the sensing transducer and the radio transmitter. This device has successfully operated during its passage through the gastro-intestinal tract.

During the past five years, at the University of California, attempts were made to perfect a passive telemetering transmitter in the form of a resonant circuit, one of the reactances of which would change in response to the variable under observation. The change in characteristic frequency was to be detected from outside the body by a 'grid-dip meter' that cyclically scanned the frequency-range. Even with several detector coils around the body to compensate for changes in orientation of the passive transmitter, the signal fell off so rapidly with distance that it was clearly desirable that the transmitter generate its signal from an associated power source.

Several alternatives exist using transistor oscillators. The person could be placed within a coil and energy induced into an internal secondary winding at a frequency quite different from that of the outgoing signal. However, a self-contained battery seemed superior. In one experiment the battery consisted of a gold and iron electrode with the internal fluids of the subject acting as the electrolyte. The low power properties of a junction transistor made such a single-cell battery adequate though the 'line voltage' varied. The stability of a self-contained miniature cell, thermostated by the body, permitted the use of simpler circuits with an overall saving of volume.

Some variables of interest are pressure, temperature and chemical composition. Pressure can be sensed by the motion of a diaphragm which moves a piece of iron within the coil of a tuned circuit controlling the oscillator frequency. The transistor itself is quite sensitive to temperature and so it can perform this sensing operation. In general, chemical analysis by potentiometry at present seems impractical because of interfering biochemical substances. However, investigation is now under way to determine a suitable combination of electrodes and circuitry to telemeter *p*H.

For easy detection of the radiated signal, a high frequency seemed desirable, though considerations of signal penetration or 'skin depth' plus the factor of transistor efficiency caused us to select a frequency in the hundred-kilocycle range. Using readily available components, the capsule is 2·8 cm. long and 0·9 cm. in diameter. Radiation is mostly from the coil itself acting as a loop antenna or primary winding relative to the receiving loop, though a small antenna could trail along behind and thus possibly also help orient the device along the direction of motion. One can track the unit through the body with a small tuned antenna or, for more precision, by X-ray observation.

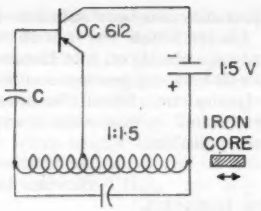

Fig. 1. Circuit of radio transmitter swallowed to transmit internal temperature and pressure. The transistor generates two frequencies and acts as a thermometer. Pressure modulation results from motion of powdered iron near coil. *C* is roughly 0·01 mfd., depending on particular transistor

The circuit that was finally evolved uses a grounded emitter connexion as shown in Fig. 1. The phase difference between collector and base allows the use of a single tapped coil (Hartley oscillator) across all of which the tuning condenser is connected to yield a given frequency with as small a coil as possible. The base connexion is through a condenser which not only results in emitter bias from the single collector battery but also, if its capacity is high enough, gives a blocking or quenching action. The radio-frequency transmits information about the pressure practically independent of temperature. The repetition-rate of the radio-frequency bursts depends on, and transmits, temperature. The burst repetition-rate does show a dependence on the pressure, but since the indication of the latter is unambiguous the temperature indication can always be corrected to the true value. Thus the tuning of a standard radio receiver indicates pressure and the tone of its output signal indicates temperature.

Calibrations are made outside the body just before and possibly after an experiment. It is actually possible under laboratory conditions to calibrate the pressure-sensing device while it is inside the subject. Since there is a sealed air space in the capsule behind the diaphragm, exposing the subject to changing atmospheric pressure allows calibration of the pressure sensitivity. Extrapolation to zero pressure, or return to any fixed value, makes possible a temperature reading completely independent of pressure. In principle, one could use a feedback system to change the external pressure on the subject until the transmitted reading was always returned to a fixed value. The external pressure would then measure the internal pressure independent of linearity or sensitivity, that is, no calibration would ever be necessary. Questions of interaction with changing temperature indications also would not arise, though in general the method seems impractical.

The concept of a radio transmitter inside a person originated because of a desire to get information about processes in the bladder during micturition. The generalization of this idea in the case of endoradiosondes that are swallowed would indicate the study of peristaltic activities including pathological conditions, the testing of spasmolytics, the monitoring of freezing anæsthesia, the possible indication of emotional states as in a 'lie detector', and the observation of metabolic activity.

This work was performed while one of us (R. S. M.) was on leave from the University of California Medical Center as a Guggenheim Fellow.

Note added in proof. A *p*H transmitter based on the reversible mechanical expansion of certain co-

polymers with acidity has been submitted for publication to the *Lancet* since the above was written. Chemical analysis based on mechanical expansion might be extended to oxygen tension with a chelate encased in polyethylene. Since the battery runs for two weeks, extended *in vivo* animal experiments of these types are possible.

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[Attention may be directed to a paragraph in *Nature* of May 4, p. 898, referring to a similar device demonstrated at the Rockefeller Institute and briefly announced on April 9.—*Editors.*]

The Sunward Tail of Comet Arend-Roland

Comet Arend-Roland (1956*h*) displayed in late April a remarkable spike-like tail directed roughly towards the Sun. This tail developed from a diffuse fan-shape on April 22 to a long and narrow spike attaining its maximum reported length of 15° on April 25.9 U.T., according to the observation of Fogelquist[1]. By April 29 the sunward tail had essentially disappeared. Van Biesbroeck[2] reported it as being a "slender jet 4° long" on April 24.1 and estimated a length of some 13° on April 25. No observations of length on April 26 are yet available to me, so it appears that the maximum extension of the sunward tail took place some time during April 25–26.

The direction of the spike has been measured on six photographs of the comet, and the deviations of the Sun from the great circle projections are plotted in Fig. 1. The photographs, which were transmitted to *Sky and Telescope Magazine*, were made by R. Fogelquist (Upsala, Sweden); C. F. Capen, jun., and B. A. Smith (State College, New Mexico); T. Sjogren (Hovas, Sweden); E. Mendoza and M. Krebs (MacDonald Observatory); and W. S. Butts (Pullman, Washington), and have been used with their permission.

From Fig. 1 it is apparent that the sunward tail swung round in position angle fairly uniformly with time and that its extension passed through the Sun within an hour or two of April 25, 17h., 1957. The Earth crossed the plane of the comet's orbit on April 25, 18h., 1957, according to the orbit calculated by Candy[3]. This time of crossing appears to be established to within an hour, in complete agreement with the time that the spike pointed towards the Sun.

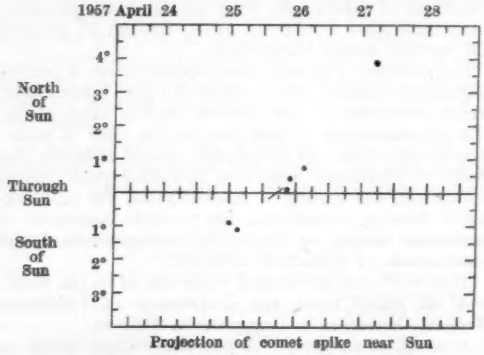

Fig. 1

No extraordinary physical theory appears necessary to account for the growth of the sunward tail by more than 10,000,000 miles in a few days and its similarly rapid decline. The sunward tail must almost certainly have resulted from the concentration of cometary debris over an area in the orbital plane. Seen at moderate angles to the plane, the material possessed too low a surface brightness to be easily observed, but seen edge-on it presented a concentrated line of considerable intensity.

The icy model[4] for the cometary nucleus provides a ready explanation for the sunward tail. The ices and free radicals sublimating from the surface of the nucleus carry with them a certain amount of fragile low-density meteoritic debris at ejection velocities somewhat smaller than the gaseous kinetic velocities. Sizeable pieces of icy material should be included in this ejection process, but at very low velocities. Once in space, under the action of sunlight, the individual icy fragments suffer sublimation on the sunward side. A jet action effectively reduces the solar attraction of an icy fragment for a short time and may move the remaining meteoritic debris away from the Sun with respect to the nucleus at velocities up to 1 km./sec. or even more. Such material will be confined largely to the plane because small velocities of ejection normal to the plane can change the inclination of the individual orbit by only a small amount. The effects of light pressure and corpuscular radiation on small low-density particles will again tend to spread them in the orbital plane.

Occluded ices and gases, escaping slowly from the meteoritic particles, can provide a small source for molecular radiations, so that the sunward tail need not give an entirely continuous spectrum. Arend-Roland is very likely a 'new comet' in the sense used by Oort[5]; Candy finds a slightly hyperbolic orbit. Even so, the comet may well have ejected the orbital debris during this first close perihelion passage.

The above deduced geometrical aspects of the sunward tail are essentially those described clearly by Bredichin[6] as early as 1877.

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[2] Biesbroeck, G. Van, Harv. Ann. Card, No. 1358 (April 26, 1957).
[3] Candy, M. P., U.A.I. Circ. No. 1585 (Feb. 20, 1957).
[4] Whipple, F. L., *Astrophys. J.*, **111**, 375 (1950); **113**, 464 (1951).
[5] Oort, J., *Bull. Astro. Neth.*, **11**, 91 (1950).
[6] Bredichin, T., *Ann. l'Obs. Moscow*, **3**, 1 (1877).

Absorption Spectra arising from the Photolysis of Lead Tetramethyl

In a recent communication[1], details were given of some unknown absorption features occurring during the flash photolysis of lead tetramethyl. While continuing this work, exposures have been obtained in which the most intense band at 3196 A. is apparently resolved into a series of *Q*-like heads. The satellite band at 3096 A. is also characterized by a central strong line-like feature and this also could be attributed to a *Q* head. There is no doubt that the bands 3196 A. and 3096 A. are related, since they

Table 1

Appearance of feature	$Pb(CH_3)_4$ ν (cm.$^{-1}$)	I	Remarks
Q head	31 186	2	
,,	31,225	6	
,,	31,255	10	Resolved heads on a diffuse background
,,	31,279	8	
,,	31,313	4	
,,	31,339	4	
Q head	32,292	4	Resolved on a diffuse background
	$Pb(CD_3)_4$		
Q head	31,280	10	Head at centre of a broad diffuse region extending from 3210 A. to 3180 A.
Q head	32,036	4	
,,	32,142	4	Clearly resolved
,,	32,246	4	

The wave-number difference of 1,025 cm.$^{-1}$ is obtained by considering a centre in the $Pb(CH_3)_4$ main band at 32,267 cm.$^{-1}$.

disappear with the same life-time, which does not appear to exceed the duration of the photolysis flash. Moreover, in repeating the experiments on the flash photolysis of lead tetramethyl-d_{12} an unmistakable shift of the 3096 A. band occurs. This band is considerably displaced towards the red while the 3196 A. band moves slightly towards the violet. The wave-numbers of all the features observed are given in Table 1. Fig. 1 is a microphotometer trace, which compares the spectra obtained in the photolysis of deuterated and undeuterated lead tetramethyl with the continuum produced by the source flash.

The isotopic shift of the satellite band towards the red means that the hydrogen atom vibrates more strongly in the upper state than in the lower molecular state; the magnitude of this shift indicates that the hydrogen atom has a large amplitude in the normal mode to which the frequency 1,025 cm.$^{-1}$ corresponds. The small shift to the violet of the 3196 A. band is in keeping with the general rule for the replacement of atoms by heavier isotopes; the substitution of heavier atoms tends to decrease the energy of the zero-point vibrations in the lower state.

The appearance of the spectrum is interesting. In the case of $Pb(CH_3)_4$, there is the most intense band

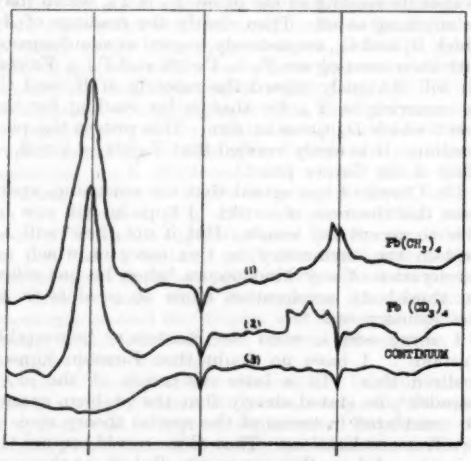

Fig. 1. Densitometric traces for spectra arising from photolysis of lead tetramethyl and lead tetramethyl-d_{12} in the region 3000–3200 A.

in the region of 3196 A. accompanied by the weaker band at 3096 A. With $Pb(CH_3)_4$-d_{12} the primary transition in the 3196 A. region is again very intense; but the satellite consists of three line-like features, each component of the 'triplet' having a separation of approximately 100 cm.$^{-1}$. There is no sign of a 'head' at the wave-length normally occupied by the $Pb(CH_3)_4$ satellite, which would be the case if the sample contained $Pb(CH_3)_4$ in any appreciable amount.

Examination of the most intense band of the undeuterated spectrum on exposures obtained under optimum conditions reveals an apparent series of Q-like heads on an unresolved background. It appears to have the characteristics of a perpendicular band of a symmetrical top molecule, but the resolution of the Hilger ($E1$) spectrograph (about 5 A./mm.) does not make such an observation at all certain.

There is a striking visual similarity between the appearance of this spectrum and those shown in the published photographs of Porter and Wright[2,3]. They point out slight differences in the characteristics of spectra which they assigned to the triplet state in aromatic vapours, compared to those attributed to free radicals such as benzyl, anilino and phenoxy. The spectra obtained by them are present, also, only during irradiation by the photolysis flash. Walsh[4] has predicted a perpendicular transition for the CH_3 radical which, if found to lie above 2500 A., would be weak. In view of the recent communication by Herzberg and Shoosmith[5], in which band spectra belonging to the CH_3 radical have been described, this might be the transition predicted by Walsh.

In polyatomic electronic spectra, frequencies of the order of 1,000 cm.$^{-1}$ are generally indicative of CH_3 bending vibrations. It seems, therefore, that the wave-number difference of 1,025 cm.$^{-1}$ corresponds to a frequency of a normal mode of the methyl group excited during the photolysis of $Pb(CH_3)_4$. On this reasoning, a plausible explanation of the appearance of three satellites when $Pb(CH_3)_4$-d_{12} is photolysed is that the wave-number differences, 755 cm.$^{-1}$, 862 cm.$^{-1}$ and 966 cm.$^{-1}$, correspond to the vibrations of CD_3, CD_2H and CDH_2. The conditions of the experiments are such that it does not seem possible to consider that transitions belonging to $Pb(CH_3)_4$ are involved. Photochemically, either the free radical $Pb(CH_3)_x$ (where x is 1, 2 or 3) or the free radical CH_3 must be considered. We have not, however, been able to obtain unequivocal evidence that would lead to an assignment being made. We have not been able to observe the 2150 A. band reported by Herzberg and Shoosmith because this region is obscured initially by strong absorption of the parent molecule and during photolysis by a continuum, which is very intense and moves rapidly towards the red end of the spectrum.

Acknowledgment is made to the Chief Scientist, Department of Supply, Australia, for permission to publish this communication.

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The 'Clock Paradox' of Relativity

Dr. Frank S. Crawford's further communication[1] is welcome as the first attempt to answer my arguments. Hitherto they have been ignored, and independent reasons, which I reject, have been adduced for the opposite conclusion. That leads nowhere.

Dr. Crawford rightly distinguishes the "qualitative" from the "quantitative" argument: these are based respectively on the 'postulate of relativity' and the 'postulate of constant light-velocity', which Einstein sharply distinguished from one another. The first states that Nature provides no phenomenon corresponding to absolute rest (later extended to cover motion in general); it is a generalization from experience and is non-mathematical. The second gives a definition for timing distant events; it is entirely mathematical and is chosen to ensure that violations of the postulate of relativity shall not be expected. Being a definition, it is, of course, not susceptible of proof; it is suggested by experience and is tenable so long as its implications conform to experience—in particular, the experiences leading to the postulate of relativity.

The argument against asymmetrical ageing rests wholly on the postulate of relativity, though I maintain that the postulate of constant light-velocity is compatible with it: the postulate of constant light-velocity is necessary to determine the age at which the twins will reunite. The argument is a single syllogism:

(1) According to the postulate of relativity, if two bodies (for example, two identical clocks) separate and reunite, there is no observable phenomenon that will show in an absolute sense that one rather than the other has moved.

(2) If on reunion one clock were retarded *by a quantity depending on their relative motion*, and the other not, that phenomenon would show that the first had moved and not the second.

(3) Hence, if the postulate of relativity is true, the clocks must be retarded equally or not at all: in either case, their readings will agree on reunion if they agreed at separation.

No flaw has been found in this. Dr. Crawford speaks of a retardation arising from "third body acceleration" with respect to the rest of the universe, "not the relative acceleration of the two twins". That is not "a quantity depending on their relative motion". But the only retardation in question in this discussion, namely, $2T\alpha \equiv 2T(1 - V^2/c^2)^{1/2}$, where $2T$ is the time of the round trip and V is the uniform relative velocity[2], *is* such a quantity. Hence his criticism is irrelevant.

I have said more than once[3] that I do not dispute a possible slight effect associated with third-body acceleration, but I cannot see how that, regardless of its magnitude, can turn $2T\alpha$ into a physical effect on a twin. This would be equivalent to the conversion of the apparent diminution of size which each of two observers sees in the other when they walk away from one another, into an actual shrinking of one of them if he alone does the walking. No one has yet explained this, and I would be grateful if Dr. Crawford would do so. If it does occur, however, then since we know, from Foucault's pendulum, for example, that the Earth has third-body acceleration, the Earth twin also should suffer the retardation and so be indistinguishable from his brother. Moreover, since Dr. Crawford holds[4] that it is only the acceleration "*while the brothers are separated*" (that is, that which occurs after a time T) that produces this effect (thus implying an unexplained distinction among third-body accelerations), how can the effect be proportional to $2T$? It would have to act retrospectively and make the ageing brother suddenly grow younger again on reversal. Is this credible?

Now consider the quantitative argument. If my syllogism holds, then such arguments are not determinations of the actuality of the asymmetry but tests of the postulate of constant light-velocity: if the postulate of constant light-velocity requires asymmetry, it fails to conform to the postulate of relativity and must be rejected. (An *experimental* proof of asymmetry, on the other hand, would require that the postulate of relativity must be rejected.) I do not believe this. Space will not allow a direct answer to Dr. Crawford's criticism of my theorem which he quotes, which I do not accept; but in view of its importance (I am surprised to find that this property of the Lorentz transformation is so little known) I will restate it and give another and more general proof to which the criticism cannot apply.

The theorem is this. Let B_1 and C_1 be two observers-cum-clocks moving with the same velocity V away from and towards, respectively, a distant object A_1 regarded as stationary. Then the events on A_1 which B_1 and C_1 regard as simultaneous with their meeting are respectively before and after, by equal amounts, the event on A_1 which an observer on A_1 regards as simultaneous with that meeting. To prove this, introduce as an intermediary an observer-clock D_1, stationary with respect to A_1 and coincident with B_1 and C_1 at their meeting. Let all three clocks, B_1, C_1, D_1, read 0 at that event, so that their co-ordinates are related by the Lorentz transformation. If x is the distance between A_1 and D_1 in their common rest frame, the event, E_0, on A_1 which is simultaneous in the D_1 co-ordinate system with the meeting of B_1, C_1, D_1 is $(x,0)$ in that system. Hence, by the Lorentz transformation, its time in the B_1 system is $Vx/c^2\alpha$, and in the C_1 system, $-Vx/c^2\alpha$. Now let A_1 be a clock identical in working with B_1 and C_1 but set at random, so that its reading at the event E_0 is T_0, which may be anything at all. Then clearly the readings of A_1 which B_1 and C_1, respectively, regard as simultaneous with their meeting are $T_0 - Vx/c^2\alpha$ and $T_0 + Vx/c^2\alpha$. A_1 will obviously regard the meeting of B_1 and C_1 as occurring at T_0, for that is his reading for the event which D_1 times at zero. This proves the proposition. It is easily verified that $Vx/c^2\alpha = \frac{1}{2}(x/c\beta - x\beta/c)$ of the former proof.

Dr. Crawford has agreed that my reasoning, apart from this theorem, is correct. I hope he will now be able to accept my result. But if not, how will he explain the asymmetry in this case, in which no acceleration of any kind occurs, when he has relied on third-body acceleration alone to produce it in the ordinary case?

I must add a word on Einstein's "regrettable mistake". I have no doubt that Einstein himself realized this. In a later discussion of the clock paradox[5], he stated clearly that the problem cannot be considered in terms of the special theory since it involves accelerations. That alone would require the rejection of the earlier argument. But about the same time he wrote a popular book, translated into English as "The Theory of Relativity" (Methuen, 1920), in which all the reasoning of the 1905 paper (other than

the technical electro-magnetic part) is retraced in order—with one omission, namely, this phenomenon of the circulating clock. This could not be because of its abstruseness—it is the simplest possible application of the theory—for even aberration and the Doppler effect are explained. I can think of no explanation except that, as he said elsewhere, he then considered the special theory inapplicable to such a problem.

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[1] *Nature*, **179**, 1071 (1957).
[2] See McCrea, *Nature*, **167**, 680 (1951); *Discovery*, **18**, 175 (April 1957).
[3] For example, *Nature*, **178**, 680 (1956); *Bull. Inst. Phys.*, **7**, 320 (1956).
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An Optical Artefact with Phase Contrast

OETTLÉ[1] notes that under certain conditions of oblique illumination objects with refractive index only slightly greater than that of the surrounding medium show an appearance "bright on one side but dark on the other". He does not consider the possibility of unintentional oblique illumination with phase contrast; it is this which has been studied in the present experiments.

These were carried out with both the standard and the Watson type of phase-contrast equipment. The systems of illumination used were these: (1) a spiral-filament bulb with bull's-eye; (2) a 'Pointolite' with bull's-eye; (3) a pearl bulb with bull's-eye (the Baker–Longworth lamp). Suspensions of xylene, methyl benzoate or tristearin in glycerine jelly were used as test objects, the two former substances giving perfectly spherical droplets, while the tristearin formed slightly irregular spheres more closely resembling the lipid inclusions of many cells. The results were the same for both types of phase-contrast system, though perhaps they were more marked with the Watson type. In all the experiments the method of Galbraith[2] for obtaining an axial beam from the lamp was used, except when the light was purposely adjusted so as to be non-axial.

When the light was axial, and all the components of the microscope were correctly centred, the globules appeared under phase contrast as perfectly symmetrical spheres, with a dark rim or apparent 'cortex' surrounding the bright region within (Fig. 1*A*). With the lamp out of alignment, so that the light entering the condenser was not axial, the appearance of the droplet was changed. The optical membrane appeared crescentic, much thickened, and at the same time the sharp definition of the dark region noted before was not obtained (Fig. 1*B*). A similar effect was produced when the light was axial but the condenser was put out of centre; with this arrangement the phenomenon was not so pronounced. It seems probable that in both these experiments the crescentic appearance around the droplet was due to an optical artefact which resulted from uneven illumination of the phase-plate annulus.

A crescentic appearance also resulted in some cases when the spiral-filament lamp was used, even though the system was in correct alignment. Inspection of the back focal plane of the objective with an auxiliary lens showed that in these cases there was uneven illumination of the phase-plate annulus, due to the differing brightness of the various parts of the image of the lamp filament.

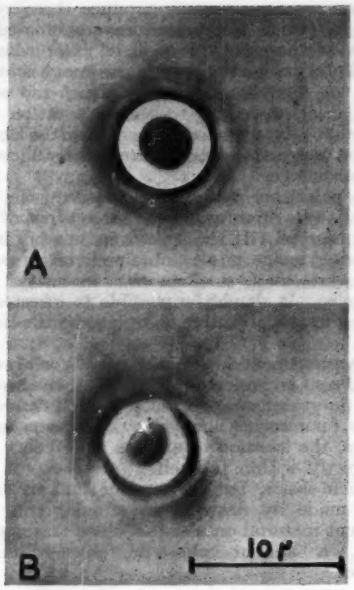

Fig. 1. The same droplet of methyl benzoate under different conditions of phase contrast microscopy; (*A*) with the illumination and microscope correctly adjusted; (*B*) with the illumination made non-axial

The 'crescent' effect which was noticed on artificial, perfectly homogeneous droplets may also occur with the lipid inclusions of living cells. Possible errors of interpretation may result; for example, the description of crescentic cortical regions around a lipid droplet that is, in fact, perfectly homogeneous. It is thus absolutely necessary to ensure that when phase contrast is used in the study of living cells, the optical system is exactly centred, the beam from the lamp truly axial, and the phase-plate annulus evenly illuminated.

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Phase-fluorescence Microscopy

IN a previous communication[1] fluorescence microscopy was introduced to the study of soil algae. However, it is most desirable and in some cases imperative to be able to observe not only the chlorophyll but also the other part of the cell. The use of fluorescent stains has proved to be not entirely satisfactory.

The normal annular disk of the phase microscope condenser is replaced by a ring of polarizing material. The normally opaque parts are replaced by a selective filter. A second ring of polarizing material is placed immediately under the first annular ring. By rotating the second ring, it is possible to control the light-intensity of the phase image.

Such an arrangement can produce three types of image: (*a*) when the polarizers are crossed, pure fluorescence microscopy is realized; (*b*) when they are parallel a practically pure phase image is obtained because the fluorescent image becomes too weak to be seen; (*c*) according to the orientation of the polarizer, any intermediate images can be obtained. Therefore, one can observe simultaneously fluorescence and phase images.

If the polarizing material is placed on the ocular, according to its orientation, the three types of images can be observed. If the specimens are birefringent, a polarizing image is also obtained. However, this arrangement may weaken the intensity of the fluorescence. It should be possible to insert a polarizing ring in the objective to overcome the difficulty above.

This arrangement is not only useful for algal work, it should also be important for any other observation where fluorescence microscopy is involved, for example, fluorescence microscopy of antigen–antibody reactions, the location of antigen then being observable directly within the cell.

A much easier, but less convenient, arrangement can be made by drawing an annular ring with a fluorescent material on a slide. When this is properly centred, a similar phase-fluorescence image is obtained.

Such arrangement does not necessarily require a phase objective. With an ordinary objective, one can obtain a bright field and fluorescent image.

Details of the work will be published elsewhere.

I acknowledge with thanks the help received from Dr. W. H. Steel and Mr. D. G. Puttock of the Commonwealth Scientific and Industrial Research Organization, Sydney.

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Direct Chelatometric Method for the Estimation of Calcium or Magnesium in the Presence of Phosphate

According to the classical procedures, determination of calcium in the presence of phosphate is carried out by precipitation as the oxalate in acetic acid medium in presence of ammonium citrate[1], and subsequent ignition of the separated precipitate. Magnesium is determined gravimetrically by precipitating it as the phosphate and this precipitate is then ignited to its pyrophosphate for weighing.

These procedures are lengthy and time consuming. Chelatometric procedures recently introduced by Schwarzenbach[2], Pribil[3] and others provide extremely rapid methods for the estimation of calcium or magnesium when present alone[4]. In the presence of phosphates, however, their estimation is attended with difficulty. Methods have recently been described in which the calcium is separated from the phosphate by ion-exchange methods[5] and the calcium thus freed from the phosphate is determined by a complexometric (chelatometric) method. Several other methods have been described which are tedious, indirect[6] or more involved. We have attempted to develop a method which is simple, direct, accurate and very rapid.

A solution of zinc complexonate is prepared by mixing equivalent quantities of a solution of zinc and disodium salt of 1–2 diamino *cyclo*hexane-tetra-acetic acid (chenta acid). This is mixed with an aliquot of the solution of calcium or magnesium phosphate and the *p*H brought to 3–4. The mixture is shaken well, and then its *p*H is adjusted to 8–10 by addition of ammonium chloride – ammonium hydroxide buffer solution, a few drops of eriochrome black *T* indicator are added and the solution titrated against a standard solution of the disodium salt of chenta acid.

In the case of a calcium solution, the titration should be carried out almost immediately at ordinary temperatures. Towards the end, however, the titration becomes slow, and the titration is completed after heating the solution to about 60–70° C. and gradual addition of the chenta.

In the case of a magnesium solution, however, the solution has to be kept hot throughout the titration, and it takes a little longer to finish the titration.

In each case the determination can be completed in a few minutes, as compared to several hours required by the usual gravimetric determination, and here the titre gives a direct measure of the quantity of calcium or magnesium.

In Tables 1 and 2 are some typical results. The determination gives the quantity of calcium (CaO) or magnesium (MgO) present in 500 ml. of the given solution containing varying amounts of phosphates; 25 ml. of the solution was used for each titration.

Table 1. Determination of Calcium in Presence of Phosphate

Molar ratio P_2O_5/3CaO	CaO (gm.) Present	Found	Error (per cent)
0·9	0·6804	0·6846	+ 0·6
2·26	0·2733	0·2731	− 0·1
2·4	0·2330	0·2343	+ 0·2
5·7	0·1022	0·1023	+ 0·1

Table 2. Determination of Magnesium in Presence of Phosphate

Molar ratio P_2O_5/3MgO	MgO (gm.) Present	Found	Error (per cent)
0·90	0·1770	0·1767	− 0·2
1·53	0·2760	0·2768	+ 0·3
4·2	0·0984	0·0984	Nil

The method is being extended to the analysis of phosphatic fertilizers, and conditions are being worked out for avoiding the interference due to other constituents normally present in these materials. Full details, with possible mechanisms of the reactions, will be published elsewhere. Our thanks are due to the J. R. Geigy Co., of Basle, for the gift of a quantity of chenta acid, which has made this investigation possible.

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Glass Strip Collector for Column Chromatography

THE glass strip collector for column chromatography to be described presents a visible result of an analysis in a manner similar to one-dimensional paper chromatography, but without the need for specific development reagents. Fractions can be isolated and estimated quantitatively.

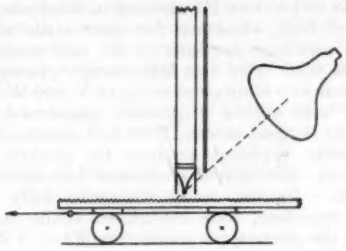

Fig. 1

A serrated glass strip (Fig. 1), 2–4 in. wide, rests on a carriage pulled along at a suitable constant speed beneath the drip point. The solvent is evaporated by heat from an infra-red lamp. A shield protects the column and the dried fractions. Excessive heat may cause longitudinal cracks in the strip. 'Vitrolite' panelling glass is used, serrated on the back with twelve serrations per inch. For colourless crystalline substances black glass is used; in other cases white or coloured glass may be preferable. Oily fractions are 'developed' by dusting with talc and brushing off the excess: this also in some cases promotes crystallization, which may take up to an hour for completion. The drip-point is shrouded to surround it with saturated vapour. This prevents creeping. For 2-in. glass a drop rate of 7 drops/min. of petroleum ether is suitable.

Fig. 2 shows the result before and after talc development from a crude benzene hexachloride extract, using a 1-cm. column with 30 gm. silica gel[1] and a speed of 0·7 in./hr.

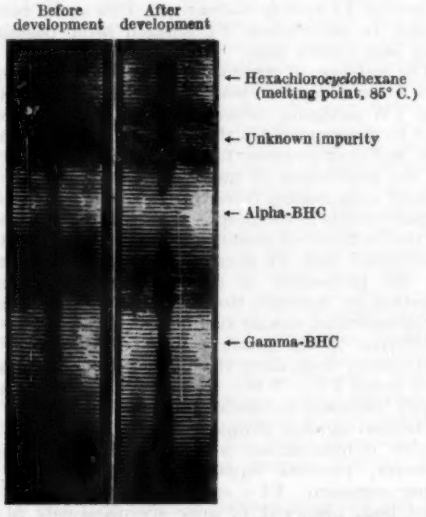

Fig. 2. The same strip before and after talc development

For isolation and quantitative recovery of fractions, the strip is hung on edge in a loop of braided nylon radio panel cord, with a smaller knotted loop at the lowest point to direct drips of solvent into a receiver. The selected fraction is washed off with any suitable solvent applied with an eye-dropper. With pure gamma-B.H.C., 20-mgm. amounts gave 98 per cent recovery when the minimum requisite heat was applied.

Flat glass was used in the early development of the method, with a T-shaped distributor hooked on to the drip-point of the column. Levelling and flow-rate were highly critical and creep was also troublesome. With the serrated glass the management is much less critical, surface tension providing the effect of closed-end troughs.

The carriage has been used also for mounting a straight rack of test-tubes as described by Grubhofer[2].

We thank Imperial Chemical Industries of Australia and New Zealand, Ltd., for permission to publish this communication.

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Biosynthesis of Acetylcholine Precursor with Choline containing Carbon-14 showing the Presence of Labile Phosphorus

SOME years ago, we found that scarcely any preformed acetylcholine exists in the organs of rabbit or frog[1–3]. Working on organs frozen in liquid air or ethyl ether mixed with solid carbonic acid until the solutions to be prepared were free from proteins and then at the lowest possible temperature, we showed that the acetylcholine found with ordinary methods was in reality present in a bound state which we called the acetylcholine precursor. We were able to show its presence in two essentially different ways[1–4]. Nevertheless, some workers were unable to show the precursor, probably due to difficulties in technique. We have been working on a method of demonstrating the precursor which is essentially different from the earlier methods. Now we are able to report the demonstration of acetylcholine precursor, which is biosynthesized from choline containing carbon-14 in its methyl groups.

Earlier, it was shown that young rats on a choline-free diet lose about two-thirds of their precursor contents. It increases swiftly to normal values when choline is given[1–3]. Therefore, young rats weighing 23–25 gm. were placed on a choline-free diet. After 7 days on this diet we injected 2 millicuries of the radioactive choline intraperitoneally. After 2 hr. the animals were killed. The hearts, livers and muscles from their hind limbs were taken out with great rapidity and frozen in a mixture of ethyl ether and solid carbonic acid. The precursor was extracted with 2 vol. of 96 per cent alcohol. The alcohol was evaporated to a final volume of 1 ml. The residue

was washed several times with ether. It was diluted with 99 per cent alcohol, which precipitates some substance containing nitrogen. The alcohol was evaporated to about 1 ml., then 80 ml. of water-free acetone was added. The acetone precipitates the precursor but not choline or its derivatives. The acetone precipitate was washed twice with the same amount of acetone. It was then dissolved in some water and washed many times with chloroform, which removes the remnant phospholipids. The residue was dissolved in water and divided into portions. These were used for the determination of the radioactive choline, for measuring the amounts of liberated acetylcholine, for quantitative measurement of free and bound phosphorus, and for qualitative test on sugar.

In the first portion we liberated the choline by heating it with 5 per cent sodium triphosphate. The liberated choline was precipitated as reineckate and the radioactivity was determined. Through comparison with 4×10^{-3} millicurie of choline we found 10 gm. of organs to contain 6×10^{-3} millicurie of choline, that is, 6 gamma of choline bound as acetylcholine precursor.

In another portion we determined the bound acetylcholine. This was liberated by adding hydrochloric acid to *p*H 5·5 and heating the mixture for 7 min. The amount of acetylcholine liberated was determined on the eserinized m. rectus abdominis of the frog. Acetylcholine was liberated.

The presence of bound choline was also shown in another way. A drop of the organ extract was put on a filter paper and afterwards dried. The filter paper strip was then placed in a flask containing 2 ml. of ammonium reineckate in methanol and 8 ml. of 99·5 per cent ethanol. No darker spot developed. If the paper strip had previously been hung for 10 min. in an atmosphere containing ammonia, a pinkish spot developed, showing the presence of liberated choline. It should be noted that a complete release of choline from lipoids such as lecithin or sphingomyelin requires 24 hr. at room temperature in *N* sodium hydroxide.

The precursor contains bound phosphorus. About 0·5 ml. of the organ extract, corresponding to 3 gm. of the organs, was treated with perchloric acid and sulphuric acid. Both acids were evaporated on a sand bath. The residue was taken up in water. The phosphorus was quantitatively determined according to a modification earlier described by Martin and Doty[5]. We found 3–3·5 gamma of phosphorus; in comparison with the amounts of choline found the amounts of phosphorus are far larger than would be found in the lipoids.

In the same amount of organ extract no, or almost no, free phosphorus could be found.

The organ extract was found to contain reducing sugar after hydrolysis[6].

A full report will be published in *Acta Pharmacologica et Toxicologica*.

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Virulence of *Pasteurella pestis*

It has widely been assumed that the antigen thought to constitute the capsule or 'envelope' which surrounds plague organisms *in vivo*[1] and which forms under suitable conditions *in vitro*[2] is essential for full virulence of *P. pestis* in mice. This antigen has been isolated by Baker *et al.*[3] and given the name Fraction 1 (F1). From their studies on the relative abilities of strains to produce F1 and toxin, Englesberg *et al.*[4] correlated high virulence for mice with ability to produce maximal amounts of F1 and toxin.

Recent work from this laboratory[5,6], however, has shown that two additional antigens V and W (VW+), together with ability to produce pigmented colonies on certain defined media (P+) and independence on exogenously supplied purines for growth (Pu+), collectively determined virulence for mice in this pathogen. Besides being toxigenic, fully virulent strains, therefore, were considered to be only those showing the phenotypic characters F1+ VW+ P+ Pu+. While F1− strains have repeatedly been isolated in the past, all, so far as I am aware, have proved to be avirulent for mice. This communication reports the occurrence of strains which retain full virulence for mice despite apparent inability to produce F1 antigen.

From the fully virulent strain *MP*6, with, of course, the characters F1+ VW+ P+ Pu+, mutant strains have been derived which lack any one, two, three or all these particular characters. As expected, selection for loss of VW only (strain *M*15) resulted in loss of ability to develop resistance to phagocytosis of the type recently investigated here[1] and in total loss of virulence. On the other hand, again as expected, selection for F1− left the ability to develop resistance unimpaired. Contrary to expectation, however, such strains, for example, *M*23, retained full virulence for mice. Strain *M*23 does not accumulate detectable amounts of F1 antigen under conditions in which it is accumulated abundantly by F1+ strains, and, *in vivo*, fails to produce the readily demonstrated envelope characteristic of wild-type virulent strains. In addition, *M*23 organisms recovered from moribund mice are not agglutinated by potent F1 specific antiserum. This strain remains unable to accumulate F1 antigen after passage in mice and guinea pigs.

The isolation of strains *M*15 and *M*23 is of importance in providing evidence to substantiate the views that VW antigens, rather than F1, determine resistance to phagocytosis in the absence of visible capsulation, and that virulence for mice cannot be conditional on the production of maximal amounts of F1. Of greater importance, however, is the repercussion on current trends in the prophylaxis of plague occasioned by the isolation of strain *M*23. Although it is firmly established that F1 antigen is of major importance for the protection of mice and monkeys against infection by 'normal', that is, F1+, virulent strains[7], it appears that strains such as *M*23, being F1−, are indifferent to the presence of F1 antibody *in vivo*. Preliminary tests show that mice actively immunized with living F1+ VW− vaccines, and thereby made highly resistant to challenge with *MP*6, have little protection against comparable challenge with *M*23. Active immunization with F1+ VW+ vaccines, however, protects equally against infection with either organism. F1− strains comparable with *M*23 have been observed to arise spontaneously *in vivo*, where they may constitute the terminal bacterial

population of mice which, following active immunization with live F1+ VW− vaccines, fail to resist challenge with strain *MP6*.

While being fully virulent for the mouse, *M*23 has shown reduced virulence for the guinea pig. In the limited number of tests which have been possible the intraperitoneal A.L.D. for this species falls between 10^3 and 10^5 organisms. It is conjectural whether, in man, *M*23 would behave as it does in the mouse or as in the guinea pig. If the former, as the relevant literature on plague would suggest, then reliance on the protection afforded by active immunization of man with purified F1 antigen would be misplaced.

I hope to report this and related work more comprehensively in a future publication.

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Phosphatases in the Central Nervous System

A histochemical study of the distribution of a number of different phosphatases in the brain of the rat has been carried out. Some of the results obtained in the cerebral cortex are worth recording. A number of different substrates were used for this purpose; but all were used at *p*H 9·0 (for evidence that these substrates are hydrolysed by different enzymes, see refs. 1, 2 and 3).

The substrates used were the following: glycerophosphate; glucose, fructose and galactose phosphates; œstrone-3-phosphate, hexœstrol and cortisone phosphates; ethanolamine phosphate, carbamyl phosphate, riboflavin-5-phosphate, phosphorylated hesperidin, pyridoxal phosphate and carboxy-phenyl-phosphate (a synthetic non-natural substance).

In all cases there was a reaction in the 'ground-substance' of the cerebral cortex; this was greatest with glycerophosphate and carboxy-phenyl-phosphate and least with pyridoxal phosphate. At the same time, however, the pyramidal cells and their processes were uniformly and strikingly negative, and there were no signs of diffusion of the reaction from the positive 'ground-substance' in which they were embedded. The nuclei were negative in the glycerophosphate preparations except for a slight reaction in the nucleolus, and in the riboflavin phosphate preparations the nucleolus gave a very strong reaction. In all the other substrates the nuclei were positive.

With the steroid phosphates, ethanolamine and carbamyl phosphates and carboxy-phenyl-phosphate the dendritic processes of the large pyramidal cells showed a concentration of enzyme activity along their membranes.

The fact that these important neurones and their processes are, though negative themselves, embedded

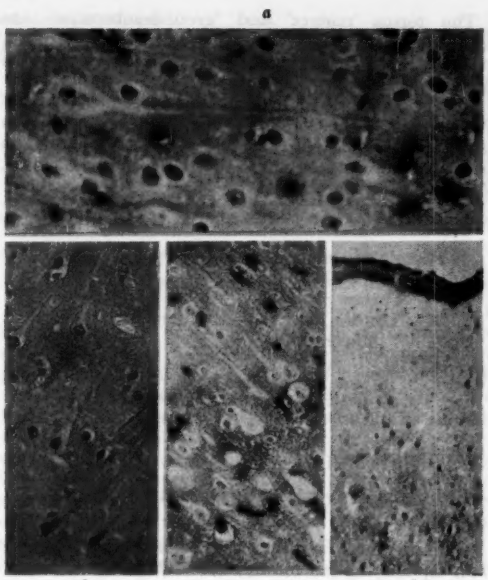

Fig. 1. *a*, Large pyramidal cells. Substrate œstrone-3-phosphate. A positive reaction is seen in the nucleolus and in a region near the nucleus which appears to be the Golgi apparatus. The strong positive reaction on either side of the axon may be seen. *b*, Positive and negative pyramidal cells. Substrate phosphorylated hesperidin. *c*, Negative pyramidal and other cells in positive 'matrix'. Substrate glycerophosphate. Positive capillaries and nucleoli. *d*, Positive cells scattered through the cortex. Substrate pyridoxal phosphate. A strong positive area underlying the pia mater may be seen

in a phosphatase-rich 'matrix' must have some functional significance.

High-energy phosphates are certain to be located in a 'matrix' giving such reactions. The wide range of phosphatases present would be capable of dealing with almost any type of phosphate ester presented to them as demonstrated by their ability to hydrolyse the non-naturally occurring synthetic carboxy-phenyl-phosphate. The added concentration of some phosphatases along the dendrites of some pyramidal cells is also of interest, and so is the fact that it is the long axons of the large pyramids which show this particularly well. This arrangement may bear some relation to synaptic transmission. It may be significant, too, that the axonal processes of the olfactory cells pass through a strongly phosphatase-rich region (the basal cells) before they leave the olfactory mucosa[4].

Another fact which should be mentioned is that in the deeper parts of the cortex many cells are found in which the nucleus, cytoplasm and processes give an extremely strong reaction with many phosphatase substrates, and in the case of pyridoxal phosphate such cells are scattered through the cortex and other parts of the brain. The functional difference between a phosphatase-negative cell embedded in a phosphatase 'matrix' and a cell in which the phosphatase is within the cell and its processes must be considerable and difficult to elucidate.

It seems that since morphological delineation of the cells of the brain has for some time virtually reached its limit, the chemical and particularly enzymic differentiation of nerve cells is obviously the next step forward in the study of neuro-anatomy.

The terms 'matrix' and 'ground-substance' are used for convenience and are not meant to imply, needless to say, that the interneuronal tissue is structureless.

Fuller details of this work will be published in the Proceedings of the Conference on "The Fine Structure and Function of the Nervous System" held at the Institute of Neurology and Brain Research, Caracas, Venezuela, in March 1957.

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Metabolism of 5 : 5-Diphenylhydantoin in the Rabbit

Butler[1] has shown that the metabolism of 5 : 5-diphenylhydantoin in man leads to the excretion of what is presumed to be the pure lævorotatory form of 5-(*p*-hydroxyphenyl)-5-phenylhydantoin, melting point 326–328° (decomp.), $[\alpha]_D^{28} - 16°$ (*c*. 0·4 in ethanol), through hydroxylation in one ring only. In dogs, however, hydroxylation of either of the two phenyl groups appears to proceed with almost equal facility: the excreted *p*-hydroxy derivative is slightly dextrorotatory.

In the course of some uncompleted work at the Wellcome Research Laboratories, Beckenham, the urine of rabbits receiving 5 : 5-diphenylhydantoin was extracted with ether at *p*H 4 and the ether evaporated after washing with water and sodium bicarbonate solution (0·1 *N*). Crystallization from aqueous acetone gave an excretion product, melting point 325° (decomp.), $[\alpha]_D^{23} - 13·5° \pm 1·6°$, $[\alpha]_{5461}^{28} - 21·5° \pm 1·6°$ (*c*. 0·59 in ethanol), $[\alpha]_{5461}^{20} - 101·5° \pm 0·5°$ (*c*. 1·49 in 0·1 *N* sodium hydroxide), which was believed to be the essentially pure lævorotatory form of 5-(*p*-hydroxyphenyl)-5-phenylhydantoin. We did not, however, consider this structure to be conclusively established, since resolution of the synthetic racemic compound[2] could not be achieved.

Dr. Butler has now kindly sent us a specimen of the excretion product from man, which we find does not depress the melting point of the metabolite from the rabbit. It seems probable, therefore, that the metabolism of 5 : 5-diphenylhydantoin follows a similar course in man and the rabbit.

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The First Observation of Sickle-Cell Hæmoglobin *E* Disease

It is likely that adult hæmoglobin (hæmoglobin *A*) and its variants are all allelomorphs, but strongly supporting evidence has so far been produced only that hæmoglobins *A*, *S* and *C* are allelomorphs[1]. The Eti-Turks are a small Arabic-speaking group in southern Turkey with a high incidence of the sickling gene[2]. When, in 1955, an Eti-Turk was discovered with both hæmoglobins *A* and *E*[3], we hoped that a family might be found in this community in which there was a segregation for hæmoglobins *A*, *S* and *E* and where we might observe a new sickling condition, sickle-cell – hæmoglobin *E* disease. Although we examined many Eti-Turks, no further cases of hæmoglobin *E* were discovered. We therefore thought that hæmoglobin *E* might perhaps be found in the Turks themselves, and that the observation on a single Eti-Turk might have been the outcome of a miscegenation. We investigated more than 400 Turks; but although we found one family with hæmoglobin *D*[4], no further instances of hæmoglobin *E* came to light.

It was therefore a fortunate chance when, after an interval of two years, one Eti-Turk was examined at Mersin State Hospital and was found to possess two hæmoglobins, one of them sickle-cell hæmoglobin and the other hæmoglobin *E*. This was the first time that 'sickle-cell – hæmoglobin *E* disease' was recognized. Furthermore, by a study of this patient's offspring, evidence has been forthcoming which suggests, though it does not conclusively prove, that hæmoglobin *E* is an allelomorph of hæmoglobins *A* and *S*, and therefore also of hæmoglobin *C*.

The propositus was a seventy-year old woman admitted to hospital because of myocardial infarction. She had a mild hypochromic microcytic anæmia. Her blood was found to be positive in the sickling test. An X-ray photograph of the skull showed a mild thickening of the diploic space and mild trabecular stripation of the parietal and occipital bones. By her first husband she had one child, and by her second husband fourteen, of whom four were still living.

Details of the hæmoglobin mixtures in her living offsprings can be seen in Fig. 2. Her hæmoglobin consisted of 40 per cent hæmoglobin *E* and 60 per cent hæmoglobin *S*. One of her sons also was a heterozygote for the genes responsible for hæmoglobins *E* and *S*. It was not possible to examine the second husband in order to make certain that he

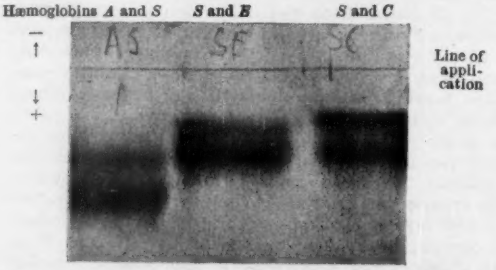

Fig. 1. Comparison by paper electrophoresis of the hæmoglobin of the propositus (*S*+*E*) with hæmoglobin mixtures *A*+*S* and *S*+*C*. The red cells were washed in isotonic saline solution, packed, and lysed by freezing and the addition of water. The hæmolysates were shaken with toluene and centrifuged to remove the stroma. Electrophoresis was carried out by the hanging-strip method on Whatman Filter Paper No. 3 "For Chromatography" in barbiturate buffer at *p*H 8·6. At the end of the electrophoretic separation the strips were dried and the hæmoglobin bands were photographed unstained

Table 1. SICKLE-CELL – HÆMOGLOBIN *E* DISEASE

The only physical complaints (apart from the myocardial infarct in the propositus) were occasional joint and bone pains. The spleen of the son was slightly enlarged

	Hæmoglobin (gm./100 ml.)	Red cells (per c.mm.)	Reticulocytes (per cent)	Cell volume (per cent)	M.C.V.* (μ^3)	M.C.H.* ($\gamma\gamma$)	M.C.H.C.* (per cent)	Osmotic fragility in sodium chloride (per cent)	Target cells	Serum bilirubin (mgm./100 ml.)
Propositus	11·4	4,750,000	3·5	45	95	24	25·3	0·40–0·26	some present	1·2
Son	13·2	5,600,000	4	52	93	24	25	0·44–0·26	9 per cent	1·6

*M.C.V. = mean corpuscular volume. M.C.H. = mean corpuscular hæmoglobin. M.C.H.C. = mean corpuscular hæmoglobin concentration.

had been a heterozygote for the genes responsible for hæmoglobins *A* and *S*; however, it is not unlikely that this was the case, in view of the high incidence of sickling among the Eti-Turks. Perhaps the fact that only four of her fourteen children from this second marriage survived was partly due to death of sickle-cell homozygotes from sickle-cell anæmia in early infancy.

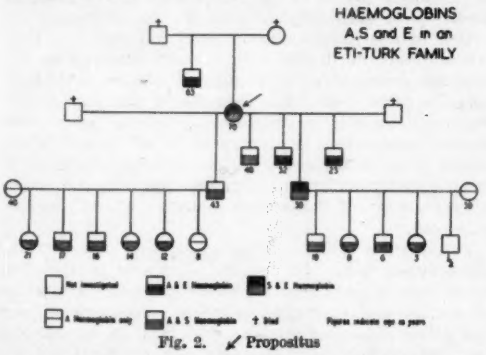

Fig. 2. ↙ Propositus

It will be seen from Table 1 that both the *SE* heterozygotes had very similar blood pictures, and it can be stated in addition that all the other carriers of the hæmoglobin *E* trait who did not also carry the gene for sickling showed no abnormality in their blood picture. In particular, there were no target cells in their blood smears.

While the likely explanation for the fact that the woman with hæmoglobins *S* and *E* had a son with the same hæmoglobin composition is the possession of the sickling gene by the deceased father, it could be argued that both hæmoglobins had been inherited independently from the mother. However, the second family, where of four children examined none had the same genotype as either parent, strongly supports the assumption that the genes responsible for hæmoglobins *A*, *S* and *E* are either alleles or are so closely linked that they segregate as if they were alleles.

One of us (M. A.) would like to thank the Blood Research Foundation, Washington, D.C., for a grant from which, among other things, a 'Spinco' *R* model paper electrophoresis apparatus used at Mersin was purchased.

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Effect of 'Starvation' upon the Constitution of Bacteria

WHEN bacteria, which have grown in a mineral salts medium, are transferred to fresh medium of the same composition a lag period may develop before growth is resumed[1]. Lag is reduced by addition of sterile culture filtrates or by certain compounds shown to be present in such filtrates[2]. We have recently observed changes within the cells themselves when they are transferred to phosphate buffer. *Esch. coli* was harvested from a growth medium containing 0·5 per cent peptone, 0·2 per cent glucose and mineral salts and the crop was divided into two equal parts. One half was disrupted immediately in the Hughes bacterial press[3] without abrasive and the crushed cells extracted with phosphate buffer. The other half of the crop was suspended in the same volume of phosphate buffer as that of the medium in which the cells had grown. After incubation at 30° C. for 2 hr. the bacteria were harvested, crushed under the same conditions as those used for the first half of the original crop and the two extracts were adjusted to the same protein content by addition of buffer. The ultracentrifuge pattern for the extract from the cells crushed immediately after harvesting from their growth medium is shown in Fig. 1*a*. It agrees closely with patterns reported by previous authors[4–6]. When the cells are incubated in the

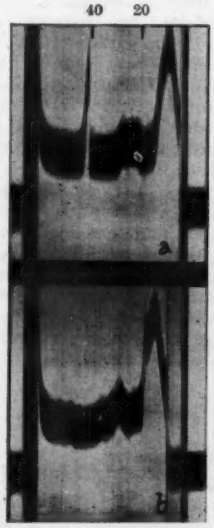

Fig. 1. Ultracentrifuge patterns for extracts of *Esch. coli* containing 12·5 mgm. protein per ml. Photographed at 24 min. after reaching speed at 187,000*g*. Extract (*a*) was prepared from cells before suspension; (*b*) from cells after suspension in phosphate buffer for 2 hr. at 30° C. The numbers above the photographs give the uncorrected sedimentation coefficients of boundaries in Svedberg units

absence of compounds necessary for growth, however, a dramatic modification occurred in the distribution of macromolecules in the extract. The leading boundary, which has an uncorrected sedimentation coefficient of 40*S*, was largely abolished while that sedimenting at 20*S* was somewhat augmented (Fig. 1*b*).

Similar observations have been made on several occasions when conditions of growth or resuspension have varied. If the bacteria were grown in media containing no peptone, that is, with ammonium sulphate as sole source of nitrogen, the macromolecules responsible for the 40*S* boundary disappeared even more rapidly from the resuspended cells. Additions to the buffer of glucose and ammonium sulphate, together or separately, made little difference to the rate at which this boundary was lost. It was only when magnesium sulphate was also added, so that the growth medium was completed and was therefore capable of supporting cell division, that the '40*S* macromolecules' were retained. A relation of this phenomenon to amino-acid metabolism is suggested by the fact that these macromolecules can still be observed for cells that have remained in cultures for long periods after growth has ceased due to exhaustion of the source of energy (glucose). Bacteria produce amino-acids in mineral salts media supporting their growth[3]. Removal of the cells from such culture fluids and their resuspension in incomplete growth media are essential for the phenomenon described.

This work forms part of a comprehensive study of the effect of growth conditions upon the macromolecular components of bacterial extracts and will be reported in full elsewhere. Meanwhile, it seemed desirable to publish this report for the following reasons: (1) Resuspension of bacteria is often resorted to, and changes such as those described are not anticipated. It should be noted, however, that the bacterial population was not concentrated in our experiments when the cells were resuspended. A concentrated suspension may show these changes only on dilution. (2) When bacteria are 'starved' the assumption is not justified that the only effect is upon the 'free amino-acid pool'. (3) The macromolecules responsible for the 40*S* boundary carry most of the bacterial ribonucleic acid[4,7]. It is improbable that their disruption has no effect upon protein synthesis and other metabolic activities. (4) The succinoxidase system[5] and other enzymes are located largely upon the '40*S* macromolecule'. If a measured biochemical activity is complex and depends upon the integrity of this particle, the treatment received by the cells may determine the activity of extracts prepared for them. (5) These macromolecules appear to have independent existence within the cells and do not arise from a stable pre-existing structure disrupted during the preparation of the extract.

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Induction of Cytoplasmic Mutations in *Aspergillus nidulans*

Mutations have been induced in *Aspergillus nidulans* (Eidam) Winter by the use of ultra-violet light and acriflavine, which, when screened by Jinks's[1,2] heterokaryon test, proved to be not nuclear but cytoplasmic in origin.

Ultra-violet light was applied to a suspension of asexual spores, which are known to be uninucleate[3] and haploid, the dose being adjusted to give 1 per cent survival. The acriflavine was added to minimal Czapek medium to give concentrations of 1 in 10^{-5} and 1 in $7{\cdot}5 \times 10^{-4}$, by weight, both asexual spores and mass hyphal propagations of the fungus being tested for changes. One certain and three probable cytoplasmic mutations have been obtained following ultra-violet treatment, and seven after acriflavine. Of the ultra-violet induced mutations no two appear to be alike, but so far as phenotypic effect goes, all seven from acriflavine appear to be identical.

One of the ultra-violet induced mutants has been investigated in detail. Following irradiation, the asexual progeny of a group of almost wild-type colonies were tested for changes in the continually varying cytoplasmic equilibria, which have been shown by selection experiments[4] to effect such characters as growth-rate. One colony was observed to be markedly different from the rest in the sharp discontinuity of behaviour shown by its asexual offspring.

Among the asexual offspring of this colony three phenotypes were observable. Colonies in the first class were a mosaic of a greater or lesser proportion of normal and abnormal growths. Members of both the other classes started as wild-type in appearance but, where the colonies were not crowded on the plate, some could be seen to continue as wild-type while others sooner or later broke down to produce some abnormal sectors. The abnormal growth was delimited by its reddish pigmentation, its reduced density of perithecia and its higher growth-rate (Table 1).

Among the classes which were initially wild-type in appearance, those which had abnormal sectors gave segregating asexual progenies, as did some of the colonies which maintained the wild phenotype. Presumably the latter would have produced such sectors had they been given opportunity. The remainder of the wild-type class gave nothing but wild-type asexual offspring. Abnormal growth invariably

Table 1. Relationship between Growth-Rate, Perithecial Density and the Proportion of Abnormal Asexual Daughter Colonies

Phenotype		Parent colony: Perithecial density (mean numbers of five random areas)	Parent colony: Growth-rate (mm./day) at 25° C.	Proportion of asexual daughter colonies with abnormal growth*
Original parent prior to irradiation		14·8	2·38	0
1	Near wild type	14·2	2·50	0
2		14·2	3·00	3·1
3		10·0	3·25	3·1
4		15·0	2·88	0
5		13·2	2·88	4·1
6	Abnormal	9·0	3·63	88·0
7		6·4	3·75	83·5
8		7·4	3·25	38·3
9		3·2	4·00	47·2
10		7·8	3·75	74·4

* Ratio based on a minimal number of 39. Colonies 1 to 10 are asexual daughters of the original irradiated uninucleate asexual spore.

gave progenies which repeated the segregation, anything from 1/3 to 9/10 of the daughters showing at least some abnormal growth. The proportion of abnormal daughter colonies was shown to be correlated with the degree of abnormal growth in the parent, the correlation coefficient being + 0·76 between growth-rate of the parent and proportion of abnormal offspring (Table 1).

The cytoplasmic basis of this segregation was proved by Jinks's test. A heterokaryon was synthesized between a line with a nuclear marker and a line giving almost entirely abnormal asexual progeny. On propagation by asexual spores from this heterokaryon, colonies with the nuclear marker and abnormal cytoplasm were obtained. These colonies maintained segregation.

A consistent explanation of the segregational behaviour follows from the assumption that the original irradiated uninucleate asexual spore contained several representatives of a cytoplasmic particle, at least one, but not all, of which was induced to mutate. The phenotypic effect of the mutant particle was virtually masked by its wild-type fellows. The presence of the mutant particle would be revealed by any segregation, or sorting out, such as might come about by the unequal distribution of the particles during asexual spore abstriction.

If we assume that the distribution of the cytoplasmic particles is at random during the production of the asexual spores it can be estimated that each asexual spore must have contained at least six particles of this kind. More confident estimates must, however, await further experiments.

I am indebted to Prof. K. Mather, Dr. J. L. Jinks, and Mr. L. G. Wigan for guidance and criticism in the preparation of this report. This work has been undertaken while in receipt of an Agricultural Research Council Studentship.

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Induction of Resistance to *A*-Methopterin in *Diplococcus pneumoniae* by Deoxyribonucleic Acid

THE study of bacteria which have become resistant to the folic acid antagonists has been used as a practical approach to the mechanism of resistance in leukæmic cells. Development of resistance in *S. faecalis*[1] and *L. citrovorum*[2] to *A*-methopterin (4-amino ^{10}N-methyl-pteroylglutamic acid) has been reported. In each case, resistance was developed stepwise as a consequence of exposure to increasing amounts of the antagonist. It has been suggested that a major factor in the acquisition of resistance by bacteria involves a reduction in the permeability of the bacterial cell to the folic acid analogues or a change which renders the susceptible enzyme less accessible to the antagonists[3]. The occurrence of such a change in leukæmic cells has not been demonstrated. This communication describes the acquisition of resistance by a susceptible strain of *Diplococcus pneumoniae* as a result of a short exposure to the deoxyribonucleic acid derived from a strain of pneumococcus resistant to *A*-methopterin.

Two rough strains of pneumococci were used in the studies to be reported. In the interest of simplicity, we shall refer to them as the *A*-methopterin-susceptible strain and the *A*-methopterin-resistant strain. The latter was derived from the former by the procedure described for *S. faecalis*[1]. Broth containing 2 μgm. of *A*-methopterin completely inhibits the multiplication of the susceptible cells, whereas the resistant cells grow and multiply unimpeded in medium containing 40 μgm. per ml.

Deoxyribonucleic acid was prepared from *A*-methopterin-resistant cells by the improved method of Avery and McCarty[4]. The technique for inducing resistance to *A*-methopterin was similar to that described for inducing other types of drug resistance in pneumococci[5]. *A*-methopterin-susceptible cells were grown in broth for 3½ hr. and then challenged with a few micrograms of deoxyribonucleic acid. Incubation at 37° C. was continued for 1–1½ hr. to allow for the lag in the expression of drug resistance. The number of resistant cells was estimated by isolating in broth made selective by the addition of various concentrations of *A*-methopterin. Small amounts of anti-pneumococcal antiserum were added which promoted growth in the form of discrete colonies.

The results of a typical experiment, carried out in duplicate, are given in Table 1. It is evident that cultures which were exposed to the deoxyribonucleic acid prepared from *A*-methopterin-resistant cells yielded greater numbers of organisms which were resistant to inhibitory amounts of the antagonist. Deoxyribonucleic acid from a strain susceptible to *A*-methopterin did not invoke a similar response. The acquired resistant characteristic is retained by the pneumococci throughout repeated subculture in the absence of *A*-methopterin. In many cases we have observed that the cells from the first or second subculture are resistant to much higher concentrations of *A*-methopterin than those to which they were originally exposed.

The effect of deoxyribonuclease and ribonuclease on active preparations of deoxyribonucleic acid has been investigated. The results indicate that the resistant characteristic is associated with the deoxyribonucleic acid. Table 2 shows the results of an experiment in which 100 μgm. of deoxyribonucleic acid was incubated, for ½ hr. at 37° C., in 0·5 ml. of 0·03 *M* magnesium sulphate containing 0·05 μgm. of deoxyribonuclease or ribonuclease. Cells susceptible to *A*-methopterin were challenged with 15 μgm. of treated or untreated deoxyribonucleic acid. It will be seen that deoxyribonuclease caused inactivation whereas ribonuclease was without effect. Similar results have been obtained in other experiments in which the enzymes have been added to cultures just prior to the addition of deoxyribonucleic acid.

Table 1

Deoxyribonucleic acid added to 1·5 ml. aliquots of culture	No. of resistant cells per ml. of culture (μgm. of *A*-methopterin per ml. of assay broth) 1	2	4
15 μgm. prepared from *A*-methopterin-resistant cells	11,488	6,276	0
	14,448	6,310	1,512
15 μgm. prepared from *A*-methopterin-susceptible cells	0	0	0
	0	0	0
Control—no deoxyribonucleic acid	124	0	0
	0	0	0

Table 2

Deoxyribonucleic acid prepared from *A*-methopterin-resistant cells	No. of resistant cells per ml. of culture (μgm. of *A*-methopterin per ml. of assay broth) 1	2	4
DNA	28,678	12,723	0
DNA treated with deoxyribonuclease	1,588	0	0
DNA treated with ribonuclease	18,260	10,425	0
Control—no DNA	794	0	0

In our experience, the number of bacteria in a population which are capable of reacting with extracellular deoxyribonucleic acid varies from one time-interval to another and from one culture to the next. The best response to deoxyribonucleic acid has been obtained in cultures which have been incubated for 3½ hr. Table 3 shows the number of pneumococci resistant to *A*-methopterin found when like aliquots of a culture were challenged with 15 μgm. of deoxyribonucleic acid, at varying time-intervals.

Table 3

Time of addition of 15 μgm. deoxyribonucleic acid from *A*-methopterin-resistant cells to 1·5 ml. of culture	No. of resistant cells per ml. of culture (μgm. of *A*-methopterin per ml. of assay broth) 1	2	4
0	90,151	24,531	1,085
20 min.	16,864	5,600	651
40 min.	6,291	2,654	0
60 min.	7,040	3,017	0
60 min. No DNA added	217	0	0

0 time indicates the period beginning 3½ hr. after starting the culture of *A*-methopterin-susceptible cells.

This work suggests that in micro-organisms the development of resistance to a folic acid analogue may be accompanied by some type of alteration in the deoxyribonucleic acid fraction of the cell. If such deoxyribonucleic acid is made available to susceptible bacteria, they may acquire resistance without ever having been exposed to the analogue.

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A Method of isolating Protoplasts from Yeast

A new approach to the structure and functions of the cell surface of certain bacteria was revealed when Weibull[1] showed that, in the presence of sucrose, lysozyme dissolves the cell-wall, leaving the protoplast essentially intact. Various attempts have since been made to isolate protoplasts from bacteria normally insensitive to lysozyme[2] and also from yeast. Thus Nečas[3] showed that spontaneously autolysing yeast gave rise to a small extent to structures which, superficially at least, resembled protoplasts.

The observation of Giaja[4] that the gut juice of the snail *Helix pomatia* dissolves the cell-wall of whole yeasts suggested a basis for an improved method of isolating the yeast protoplast. Following this suggestion, it has been found in these laboratories that the cell-walls of certain strains of *Saccharomyces carlsbergensis* and *Saccharomyces cerevisiae* are particularly susceptible to attack by the snail enzyme, and the investigation has been further assisted by the observation that freeze-dried preparations of the enzyme are stable for at least a year[5].

In the light of Weibull's work with bacteria, we have now shown that by digesting the intact yeast with snail enzyme in the presence of a relatively high concentration of sugar, stable protoplasts may be obtained. Under these conditions, however, the digestion of the wall is rather slow and only proceeds to completion when young cells are used. Moreover, the yield is also influenced by the nature of the sugar. For example, in the presence of glucose the yeasts rapidly lyse during digestion unless the temperature is reduced in the later stages to about 4° C. This circumstance may be avoided by using rhamnose, possibly because it is a substance which is not metabolized. In the light of these observations, therefore, the following method of preparing the protoplasts was developed.

Young cells of either of the above yeast species are obtained by inoculating a small volume (0·2 ml.) of a mature culture into Wickerham's malt-extract medium[6] (500 ml.) and shaking the culture at 25° C. The cells are harvested after about 18 hr., when a population density of approximately 6×10^8 cells per ml. is attained. After thorough washing in distilled water, the young yeast is suspended at a density of about 10^8 cells/ml. in 0·005 *M* citrate-phosphate buffer (*p*H 5·8) containing 0·55 *M* rhamnose and 1·0 mgm./ml. of the freeze-dried snail enzyme. After about 18 hr. at room temperature, or about 5 hr. at 25° C., more than 90 per cent of the cells are converted into protoplasts, the remainder being completely dissolved. Despite their fragile nature, the protoplasts can then be washed and centrifuged at low speeds in 0·5 *M* solutions of rhamnose buffered at *p*H 5·8, in which they appear to be stable for several hours.

Fig. 1 shows, diagrammatically, stages in the release of protoplasts from the strain of *S. carlsbergensis* in which the cells (Fig. 2) are of an elongated form, in contrast to the spherical protoplasts derived from them (Fig. 3). Examination under phase contrast shows that the protoplast retracts from one or both poles of the cell at an early stage of the digestion. Later it extrudes through a hole in the cell wall which develops during digestion and which frequently seems to occur at the site of a bud scar. Finally, the cell wall from which the protoplast has emerged is completely dissolved, leaving a suspension of protoplasts essentially free from either whole yeasts or debris.

Fig. 1. Stages in the release of the protoplast of *S. carlsbergensis*

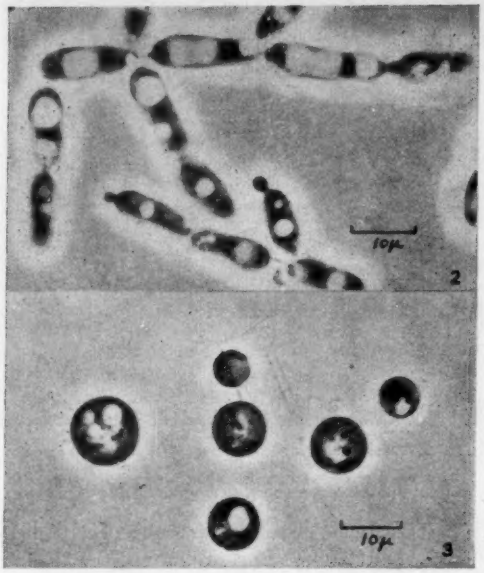

Fig. 2. Young cells of *S. carlsbergensis*. Phase contrast
Fig. 3. Isolated protoplasts of *S. carlsbergensis*. Phase contrast

In sugar solutions more concentrated than 0·5 *M* the isolated protoplasts are found to contract and become crenate. At lower concentrations, on the other hand, they tend to swell and eventually burst. It is interesting that in the latter case the surface membrane appears to disintegrate and a spherical structure, tentatively identified as the vacuole membrane, separates from the debris. Such bodies are found in large numbers in suspensions of burst protoplasts. This and other aspects of the structure and functions of the isolated yeast protoplasts, including the possibility that they may regenerate cell walls (cf. Nečas[3]), are now under active investigation.

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Tranquillizing Drugs and Morphine-mania in Cats

Chlorpromazine has been shown to potentiate morphine analgesia[1–3], while reserpine antagonizes the analgesia[2] as well as the central stimulatory action of morphine in the Straub tail reaction and in activity tests[4] with mice. On the other hand, small doses of reserpine potentiate the mydriatic action of morphine in mice and large doses produce a meiosis characteristic of reserpine alone[4]. Since morphine produces a peculiar excitant or manic state in cats[5], we were interested in the possible influences of these tranquillizing drugs on the morphine reaction in this species.

Morphine-mania was consistently obtained in thirteen cats after subcutaneous injection of 20 mgm./kgm. These cats were highly excitable, apprehensive, ataxic, and displayed marked mydriasis. Milder effects were obtained in five cats with 5–10 mgm./kgm. and none in two cats with 3 mgm./kgm. Chlorpromazine alone caused mild tranquillity, ataxia, relaxation of the nictitating membrane, and moderate meiosis in twenty-one cats after intra-muscular injection of 20 mgm./kgm.; progressively milder effects were seen in groups of four cats each injected with 5, 2 and 0·5 mgm./kgm. Reserpine alone, after intraperitoneal injection of 0·1–0·5 mgm./kgm., produced in ten cats a deep tranquillity approaching catatonic stupor, relaxation of the nictitating membrane, and marked meiosis; these signs persisted for several days, accompanied by anorexia and diarrhœa.

The interactions of morphine (20 mgm./kgm.) and chlorpromazine (20 mgm./kgm.) were observed in five cats, three receiving the tranquillizer several hours after morphine and two several hours before. Chlorpromazine caused relaxation of the nictitating membrane and partially antagonized the excitement but not the mydriasis caused by morphine. These results are similar to those obtained by other workers[6,7], but are in contrast to the effect of chlorpromazine on morphine analgesia[1–3]. Combinations of morphine (20 mgm./kgm.) and reserpine (0·1–0·5 mgm./kgm.) were administered to seven cats, two receiving the tranquillizer several hours after morphine and five several hours before. In the former case, reserpine caused relaxation of the nictitating membrane, meiosis and partial antagonism of the morphine-excitement; in the latter case, mydriasis and typical mania ensued, resulting in two deaths, and, later, reserpine sequelæ were seen in the remainder. These results are consistent with the earlier reports of morphine-antagonism by reserpine[2,4]. In two additional morphine-manic cats, we were unable to confirm the antagonistic action of 20 mgm./kgm. subcutaneous injection of azacyclonol (α-(4-piperidyl)-benzhydrol hydrochloride, synthesized by Dr. Kurt Rorig, Division of Chemical Research) reported by Brown and co-workers[8].

In summary, the severity of morphine excitement in cats was lessened by chlorpromazine and reserpine. The mydriatic effect of morphine predominated over the meiotic effect of the tranquillizers, except when reserpine was given several hours after morphine. Relaxation of the nictitating membrane by the tranquillizers was not affected by morphine.

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Pathological Melanosis in an Intergeneric Hybrid

During the past three years, I have been working on the genetics of an apparent intergeneric cross between two viviparous cyprinodonts, *Xiphophorus helleri* and *Mollienisia sphenops*. Some of the results obtained may interest not only geneticists but also those engaged in the fields of endocrinology and cancer research.

A pair of the putative hybrids was obtained from the breeder, Mr. W. Woodward, who stated that the mother was an albino swordtail (*Xiphophorus helleri*) and the only possible father was a black *Mollienisia sphenops*. The mother had been isolated from all other viviparous males for nearly a year. At the end of this period she produced four successive broods at the normal, monthly, intervals.

This is certainly a very unusual cross; but Prof. J. H. Vivien, of Strasbourg, in a personal communication, tells me that one of his students has worked with *Xiphophorus* × *Mollienisia* hybrids, and the curator of Edinburgh Aquarium says that they have obtained this cross three times.

The young from Mr. Woodward's albino female were mostly black-striped green fish, with a few plain greens and plain reds. The fish with black pigment were large and heavily built, the others were abnormally small. In form they were of the *Xiphophorus* type, the only recognized *Mollienisia* character being the black pigmentation.

Extreme matroclinous inheritance has been observed before in viviparous cyprinodonts. I have myself had broods from a definitely virgin *M. sphenops* where the only possible father was a *Heterandria formosa*. The young showed no recognizable paternal characters but became sexually mature at two months instead of the normal five. A virgin *Lebistes* mated with one of these fishes produced *Lebistes*-type young with a quite abnormal sex-ratio in the F_2. *M. sphenops* × *M. latipinna* hybrids are intermediate in character; but these hybrids when mated with males of other genera produce young which are indistinguishable from the mother.

In Mr. Woodward's cross parthenogenesis and self-fertilization can both be ruled out since an albino swordtail must be homozygous for the recessive factor *i* which inhibits the development of melanin, and therefore all 'fatherless' offspring must necessarily be albino. The factor for black, presumably inherited from the *Mollienisia* male, behaves most abnormally. It is apparently not inhibited by the albino factor since no proper albinos have ever appeared in any of the broods resulting from matings between black-pigmented fish. Some of these offspring, however, have albino patches. In matings with virgin golden wagtail platies no black appears on the body, although the inheritance of another factor proves that true fertilization has taken place. A detailed account of the genetics of this cross will be published in the *Journal of Genetics*.

There are many suggestions of hormone imbalance in these fish. The sex ratio in many broods is highly abnormal and apparent sex reversal is common. Still more striking are the extraordinary differences in size and age of maturity. The plain-coloured males always seem to mature rather early and to be distinctly undersized. Many are absolute dwarfs and in these sexual precocity is extreme, that is, they mature at 6–7 weeks. The fish with black pigment, on the other hand, all tend to be large and abnormally heavily built and these become mature at five months or later.

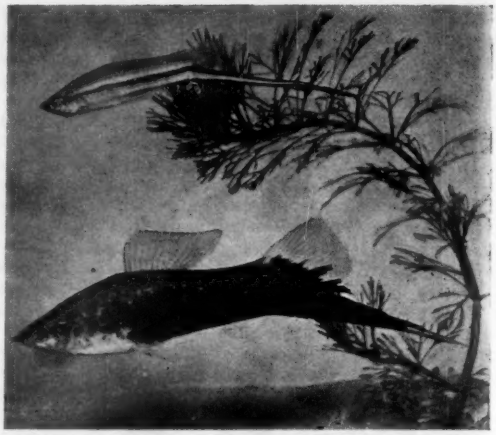

Fig. 1. Typical male hybrids. The upper fish became sexually mature at 7 weeks, the lower at 5 months. These fish are both fully grown and show the typical difference in size between fish with and without black pigment. (Photograph by L. C. Mandeville)

In a high proportion of the hybrids melanin formation becomes pathological, and most of the heavily pigmented fish develop melanomas. These melanomas have been serially sectioned and examined at the Chester Beatty Research Institute. Although the pigment is spread over a very large part of the body, all the melanomas so far observed have originated in the same position, in the lower half of the caudal peduncle, at the base of the caudal fin. In this respect these melanomas differ from those found in *Xiphophorus helleri* × *Xiphophorus maculatus* hybrids, where the melanomas appear practically anywhere in the black areas.

There are other points of difference between the melanomas which arise in this intergeneric cross and the melanomas which appear in intrageneric crosses of the *Xiphophorus* species, which have been studied in great detail by Myron Gordon and others. Although the growth in the *Xiphophorus* × *Mollienisia* hybrids may be very malignant, with extensive penetration into the underlying tissues and a thick solid black overgrowth which completely covers the underlying scales, so far no actual discrete secondary growths have been observed and there is no distortion or erosion of the fins as in the Gordon melanomas. The growths are frequently fatal but the actual cause of death is still somewhat obscure. Quite often the fish appear fairly healthy and are very active, with good appetites, right up to the end, but sometimes there is severe wasting and often severe dropsy of the whole body occurs shortly before death. The appearance of the melanoma is not correlated with ageing; in fact, the most usual time of onset seems to be the period at which the fish begins to develop its sexual characters.

Perhaps the most important observation made so far is that in some cases the melanoma spontaneously regresses. A complete cure occurred in two cases, in another there was a remission followed by regression. Other cases of spontaneous cure are suspected from the presence of scars, but the fish concerned were living in a large aquarium and were not individually observed.

Huxley believes that in the Gordon hybrids the normal control of the growth of macromelanophores has been lost through hybridization, the modifying factors which have arisen during evolution being upset through the introduction of the foreign genes. The same thing has probably occurred here. In my hybrids there are obvious signs of endocrine imbalance, and it is suggested that this may lead to melanoma formation. Since the pituitary controls the development of the melanophores to a certain extent and there are other abnormalities which might be explained by a hypothesis of pituitary imbalance, an attempt will be made to investigate the action of this endocrine organ in these hybrids. It is also proposed to attempt to repeat this cross and to make other interspecific and intergeneric crosses, by artificial insemination.

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Colour Change in a Chelonian

VARIOUS species of Pisces, Amphibia and Reptilia exhibit reversible colour change according to lighting conditions. According to Parker[1], Chelonia is the only order of Reptilia from which no example of this activity has been described. It is the purpose of this communication to record colour change in a tortoise (*Chelodina longicolis*).

For the observations that follow, the tortoises were kept in water with continuous overhead illumination either in tanks painted white (afterwards referred to as white background) or in tanks painted black (afterwards referred to as black background). With a black background, light impinges only on a circumscribed area (*B*) of the retina and, on a white background, the whole of the retina is illuminated[2]. This animal has webbed feet so, as with amphibians and fish, direct visual estimation of the melanophore condition in the living animal is possible. I can trace no previous record of such observations with a reptile.

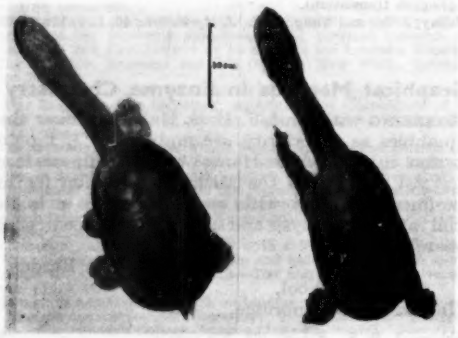

Fig. 1. Macroscopic appearance of pale and dark animals

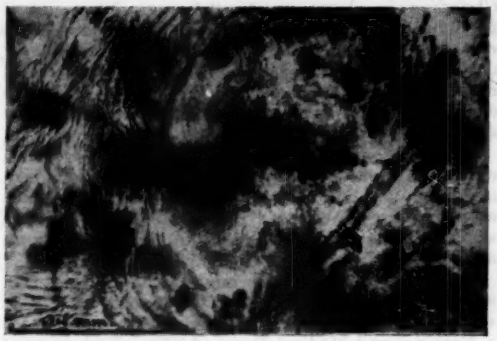

Fig. 2. Melanophores from web of animal maintained on a white background. Dermal and epidermal melanophores contracted

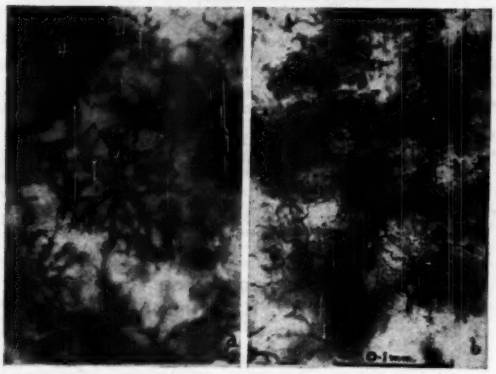

Fig. 3. Melanophores from web of animal maintained on a black background. Dermal (*a*) and epidermal (*b*) melanophores expanded

Animals maintained on a white background have contracted melanophores and are macroscopically pale and on a black background the melanophores are expanded and the skin is dark (Figs. 1–3). After transferring an animal equilibrated on a white background to a black background it takes approximately 30 days for the melanophores to expand fully. The reverse change takes about the same time. The time relations of these responses are nearer to those of the eel[3] than those of any other animal so far described, both as regards speed and the near equivalence of *bTw* and *wTb* [2]. The speed of response suggests that it is hormonally co-ordinated[4] and consequently injections of melanophore expanding (*B*) pituitary hormone were made.

Intraperitoneal injections of crude '*B*' containing extracts of whole pituitary powder caused melanophore expansion in pale animals. A dose sufficient to cause expansion maintained the animals in the dark state for several days, after which there is a slow return to the pale state. In this respect also it is similar to *Anguilla*[5]; it appears that injected *B*-hormone is only slowly destroyed.

Adrenaline causes contraction of the melanophores in all animals in which the melanophores are innervated directly and it also has the same effect in some animals in which there is no evidence of direct innervation. Recently, Burgers[6] has described expansion of the melanophores of *Xenopus* following injections of adrenaline. Injection of adrenaline into

Chelodina in doses up to 0·1 mgm./kgm. intraperitoneally and 0·02 mgm./kgm. intravenously did not evoke a melanophore response in either pale or dark animals. Although other workers have used much larger doses of adrenaline in other animals the above quantities were not exceeded since they were sufficient to evoke very large blood pressure responses.

Although only preliminary observations have been made it is apparent that the co-ordinating mechanism is dominantly humoral and this permits us to place another item in Waring's 1942 table[7]; the Chelonia are known as a separate order from Permian times and the family Chelyidae since Miocene.

These observations were made incidentally during an investigation of pituitary vasomotor effects in vertebrates. Grateful acknowledgment is made for a National and Medical Research Council (Australia) grant to Prof. H. Waring.

P. Woolley

Zoology Department,
University of Western Australia. Jan. 25.

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Influence of Some Factors on the Relative Evaporation Rate from the Skin of Cattle

The rate of evaporation from the skin plays an important part in the thermoregulatory adaptation mechanism of cattle in a high-temperature environment. In the present investigation a method for the determination of the relative evaporation-rates of the skin was examined and employed to determine the evaporation-rate for different regions of the body, its variability among cows, and the factors affecting this variability.

This method, previously used by Volcani and Schindler[1], is based on the colour changes upon hydration of cobalt chloride anhydride. A solution of 10 per cent cobalt chloride was absorbed in filter paper which was afterwards dried, then cut into small disks of equal size, dried once more at 105° C. overnight, and finally transferred in test-tubes to a desiccator. To measure evaporation, a disk was introduced into a small cylindrical glass cup, which was immediately pressed on to the skin. The time taken for the colour to change from violet to bright rose was recorded by a stop watch. This depends on both the primary vapour pressure of water in the atmosphere of the cup and the rate of evaporation from the skin. Under constant primary vapour pressure, the time of colour change is inversely related to the evaporation-rate from the skin. Therefore this method is well suited for comparative measurements of evaporative-rates under constant vapour pressure of water in the air.

This experiment was carried out in the Jordan Valley on a group of 221 Holstein × Syrian F_1–F_{10} cross-bred cows.

Evaporation-rates of different body regions. Evaporation-rates were measured at fourteen parts of the body, namely, muzzle, forehead, lateral neck, ventral neck, thoracal back, sacral back, thigh, front flank, abdomen, udder (fore, lateral and rear), teat base and vulva. The highest evaporation-rates occurred in the following diminishing order: muzzle, lateral neck, vulva, ventral neck and front flank; whereas the slowest rates occurred on the abdomen, forehead and udder respectively. The differences were highly significant. These relations follow generally the regional distribution of the sweat glands' evaporative surface[2].

White spots had a slower evaporation-rate than black spots, but the difference was not significant in the conditions of these experiments.

The increase in evaporation-rate due to shearing was great and highly significant. The interaction cows × shearing was significant, but the correlations between evaporation-rate and weight of hair per 100 cm.², and that between evaporation-rate and density of hair per 100 cm.², were very low and non-significant.

Variation in evaporation-rate of different cows. For this purpose, the front flank (black colour) was taken as the standard recording place. The variation found was highly significant. An analysis of the factors of variation revealed that increasing the percentage of relationship to the Holstein breed in the Holstein × Syrian cross-bred cows from 75 to 99·2 per cent did not influence the evaporation-rate. A highly significant variation was found among groups of the daughters of cows from different sires. The sires were of the Holstein breed (Canadian and Israeli origin), and Holstein × Syrian F_2 cross-breds. The daughters of the Holstein × Syrian F_2 cross-bred sires did not show a higher rate of evaporation than the daughters of the Holstein sires.

These results point to the possibility of increasing skin evaporation-rates in cattle by using sires capable of transmitting the characteristic of higher evaporation-rates to their offspring, and by shearing the coat of cattle, rather than by cross-breeding alone.

This investigation forms part of a progress report of work carried out under the guidance of Dr. R. Volcani in partial fulfilment of the requirements for the Ph.D. degree. A detailed account will be published elsewhere.

This study is part of an Agricultural Research Station, Rehovot, research project on acclimatization problems of dairy cattle in Israel.

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Faculty of Agriculture,
Hebrew University, Rehovot.

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Graphical Methods in Enzyme Chemistry

Agreeing with Prof. J. B. S. Haldane's view that "Squabbles as to priority are undignified"[1], I point out that in 1932 C. S. Hanes[2] used the linear form $x/v = x/V + K/V$ of the Michaelis equation for his experimental results with amylase, where v is the initial rate of hydrolysis and x the initial concentration of starch.

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Botany School,
University of Cambridge.

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FORTHCOMING EVENTS

Monday, June 17

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Council Room (second floor) of the Science Museum, Exhibition Road, South Kensington, London, S.W.7), at 5.30 p.m.—Dr. H. Hamshaw Thomas, F.R.S.: "Carl Linnæus and his Influence on the Development of Biology".

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. M. G. Kendall: "On Probability".

Tuesday, June 18

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

Wednesday, June 19

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Scientific Papers.

Thursday, June 20

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. C. F. Powell, F.R.S.: "The Elementary Particles" (Bakerian Lecture).

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—50th Annual General Meeting, followed by Dr. A. J. Haddow: "The Work of the Virus Research Institute at Entebbe".

Saturday, June 22

BRITISH PSYCHOLOGICAL SOCIETY (in the Gustave Tuck Theatre, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Prof. H. J. Eysenck: "Personality as an Integrating Concept in Psychology".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PRINCIPAL (with a university degree in engineering or science or equivalent (for example, A.M.I.Mech.E.), and experience in responsible posts in technical education) OF BELIZE TECHNICAL COLLEGE, British Honduras—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.114/31/04 (June 21).

CHEMIST (with an honours degree in chemistry or equivalent qualification, and preferably knowledge or experience of agricultural chemistry or horticulture), for nutritional and other studies relating to glasshouse and other crops—The Secretary, Glasshouse Crops Research Institute, Worthing Road, Rustington, Littlehampton, Sussex (June 22).

JUNIOR LECTURER IN MATHEMATICS—Prof. E. C. Titchmarsh, Mathematical Institute, The University, Oxford (June 22).

SENIOR LECTURER or LECTURER (with special qualifications in pure mathematics) IN MATHEMATICS—The Secretary, The University, Exeter (June 24).

SENIOR PHYSICIST FOR DUTIES IN THE RADIOTHERAPY DEPARTMENT—The Secretary, North Middlesex Hospital, London, N.18 (June 24).

ASSISTANT (graduate, with library qualifications and experience) IN THE LIBRARY—The Registrar, The University, Nottingham (June 29).

ASSISTANT LECTURER IN ANATOMY—The Secretary, Royal Free Hospital School of Medicine (University of London), 8 Hunter Street, London, W.C.1 (June 29).

ASSISTANT LECTURER IN GEOGRAPHY—The Registrar, The University, Hull (June 30).

KEEPER (with a university degree in botany or zoology or the Diploma of the Museums Association, and previous museum experience) OF THE DEPARTMENT OF BIOLOGY in the Leicester Museums—The Director, Museums and Art Gallery, New Walk, Leicester (June 30).

LECTURER IN ZOOLOGY at Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1) (New Zealand, June 30).

NEMATOLOGIST, for duties which would include investigations into host relationship of grass and other crops with respect to their suitability as a rotation crop with tobacco, together with a study of environmental factors favouring the reproduction of parasitic nematodes and the development of assay technique—The Director, Tobacco Research Board of Rhodesia and Nyasaland, P.O. Box 1909, Salisbury, Southern Rhodesia (June 30).

RESEARCH ASSISTANT (preferably with a Ph.D. degree), for work on the stereochemistry of piperidines and quinolizidines with special reference to quinolizidine alkaloids—The Secretary, The University, Exeter (June 30).

RESEARCH ASSISTANT, to work on fundamental theoretical research in electromagnetism—The Secretary, Department of Electrical Engineering, Queen's College, Dundee (June 30).

BENGER RESEARCH FELLOW (graduate in medicine or science (including pharmacy) or with other suitable qualifications) IN PHARMACOLOGY—The Registrar, The University, Manchester 13 (July 1).

FARM DEMONSTRATOR (with a degree in agriculture, or an honours degree in pure science, followed by an adequate postgraduate qualification in agriculture, together with farming experience)—The Secretary, School of Agriculture, The University, Cambridge (July 1).

FELLOW (man or woman graduate) IN CHEMISTRY, to undertake a research project involving the measurement of physico-chemical properties of organic systems—The Principal, Royal Holloway College, (University of London), Englefield Green, Surrey (July 1).

LECTURER (graduate in metallurgy or chemistry, with special qualifications in the theory of extraction metallurgy) IN METALLURGY—The Registrar, The University, Manchester 13 (July 1).

RESEARCH ASSISTANT IN INSECT ECOLOGY—The Registrar, The University, Leeds (July 1).

RESEARCH STUDENTS (with the degree of Bachelor or Master of a British university, other than Manchester) IN SCIENCE—The Registrar, The University, Manchester (July 1).

CHAIR OF BOTANY in the University College of Ghana—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (July 5).

LECTURER IN PSYCHOLOGY—The Secretary, The University, Aberdeen (July 5).

DEMONSTRATOR (preferably candidate wanting research experience in cytology) IN THE DEPARTMENT OF BOTANY—The Registrar, The University, Leeds 2 (July 8).

LECTURER IN PHYSICS at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, July 8).

LECTURER IN THE DEPARTMENT OF GEOLOGY AND MINERALOGY at the University of Adelaide, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, July 15).

LECTURER (well qualified in the fields of educational psychology, educational and psychological tests and statistics) IN EDUCATION at Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, July 15).

RESEARCH FELLOW IN THE INSTITUTE OF EDUCATION (University College of Rhodesia and Nyasaland), to investigate problems posed by the early development of technical education in the Federation—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (July 15).

SENIOR LECTURER or LECTURER IN BACTERIOLOGY at University College, Ibadan, Nigeria—The Secretary, Senate Committee on Colleges Overseas in Special Relation, University of London, Senate House, London, W.C.1 (July 15).

SCIENTIFIC OFFICERS (2), for work on plant virus diseases—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (July 20).

CHEMIST/ASSAYER (with a first- or upper division second-class honours degree in chemistry, and preferably two years postgraduate research or experience as chemist) IN THE DEPARTMENT OF GEOLOGICAL SURVEY, Government of Northern Rhodesia, to carry out assays of ores, and the analysis of minerals and rocks and other determinations in the Geological Survey Laboratories—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.105/3/03.

DEMONSTRATOR IN AGRICULTURAL CHEMISTRY—The Registrar, King's College, Newcastle-upon-Tyne.

DEMONSTRATORS (2) IN PHARMACY—The Registrar, The University, Nottingham.

GRADUATE COMPUTER (with a degree in mathematics or statistics, or with experience in computing), for planning, programming and processing of punched card tabulations, with eventual use of an electronic digital machine—The Secretary, Oxford University Institute of Statistics, St. Cross Road, Oxford.

MASTER TO TEACH PHYSICS to advanced level, and to take charge of the subject—The Head Master, Boys' Grammar School (Central Foundation Schools of London), Cowper Street, London, E.C.2.

PHYSICISTS (with, or obtaining, a first- or second-class honours degree or equivalent) at Ministry of Supply Experimental Establishments, mainly in the South of England, for research and development directed towards the solution of problems and the development of new ideas in various fields including aircraft and aircraft equipment; gas turbines and jet engines; improved cross-country vehicle mobility; guided missiles and other armaments; instrumentation; radio, radar and communication equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.420/6A.

PRINCIPAL RESEARCH OFFICER (with good academic qualifications and proved ability to conduct and direct research); and a RESEARCH OFFICER or ASSISTANT RESEARCH OFFICER (with a minimum of 4 years university training and holding a B.Sc. (Hons.) or M.Sc. degree in chemistry, or equivalent, with physics and/or mathematics as auxiliary subjects) with the South African Council for Scientific and Industrial Research, National Chemical Research Laboratory, Division of Physical Inorganic and Analytical Chemistry, Pretoria—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2.

RESEARCH ASSISTANT (with, or candidate for, the B.Sc. (Special Chemistry) degree of the University of London) IN CHEMISTRY—The Registrar, Brighton Technical College, Brighton, Sussex.

SENIOR LECTURER (man or woman, with a good honours degree in mathematics or general honours degree, including mathematics, and varied teaching experience) IN MATHEMATICS at Nottinghamshire County Training College for Women, Eaton Hall, near Retford—The Director of Education, County Hall, Trent Bridge, Nottingham.

SENIOR LECTURER (preferably with a degree in agriculture and sound practical and teaching experience) IN AGRICULTURE at Kirkley Hall Farm Institute—The Director of Education, County Hall, Newcastle-upon-Tyne 1.

SENIOR LECTURER (with at least five years experience of teaching and laboratory work at a British university, and experience of high voltage practice) IN ELECTRICAL ENGINEERING at the University of Rangoon, Burma—The Ministry of Labour and National Service, (E9), Almack House, King Street, London, S.W.1, quoting A.12/BUR/TCS/88.

SENIOR MATHEMATICAL MASTER—The Head Master, Bedford Modern School, Bedford.

SENIOR SCIENTIFIC OFFICERS (with a first- or second-class honours degree in physics, and postgraduate experience in nuclear physics) to carry out fundamental studies in the field of fast neutron physics—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting Ref. 1501/34.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Kent Incorporated Society for Promoting Experiments in Horticulture. East Malling Research Station, Annual Report, 1956 (1st October, 1955 to 30th September, 1956). Forty-fourth Year. Pp. xxiii+196+44 plates. (East Malling, Maidstone: East Malling Research Station, 1957.) [164

The South-Eastern Naturalist and Antiquary: being the Sixtieth volume of Transactions of the South-Eastern Union of Scientific Societies; including the Proceedings at the Sixtieth Annual Congress held at Folkestone, 1955. Pp. xxv+34. (London: South-Eastern Union of Scientific Societies (Hon. General Sec. and Hon. Treasurer: Frank Edwards, 53 The Drive, Shoreham-by-Sea), 1957.) 6*s.* 6*d.* net. [234

Ciba Foundation for the Promotion of International Co-operation in Medical and Chemical Research. Report for 1956. Pp. 43. (London: The Ciba Foundation, 1957.) [234

Physical Society. Report of the Meeting on Semiconductors held by the Physical Society, in collaboration with British Thomson-Houston Ltd., Rugby, in April 1956. Pp. 153. (London: Physical Society, 1957.) 12*s.* 6*d.* to members: 20*s.* to non-members. [234

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The Royal Charter of the Imperial College of Science and Technology—Jubilee 1907–1957. Pp. ix+37+6 plates. (London: Imperial College of Science and Technology, 1957.) [294

Other Countries

United States Department of the Interior: Fish and Wildlife Service. Research Report 42: Biology of Young Lake Trout (*Salvelinus namaycush*) in Lake Michigan. By John van Oosten and Paul H. Eschmeyer. Pp. ii+88. 40 cents. Research Report 43: Effect of Pulse Frequency and Duration in Guiding Salmon Fingerlings by Electricity. By Howard L. Raymond. Pp. ii+19. 15 cents. Research Report 44: Biology of the Sea Lamprey in Its Parasitic Phase. By Philip S. Parker and Robert E. Lennon. Pp. ii+32. 20 cents. Research Report 45: Preparation of a Dry Product from Condensed Menhaden Solubles. By C. F. Lee. Pp. ii+33. 20 cents. Fishery Bulletin 105: Method of Evaluating Temperature in Lakes with Description of Thermal Characteristics of Convict Lake, California. By Norman Reimers and Bobby D. Combs. Pp. ii+535–554. 20 cents. Fishery Bulletin 107: Validity of Age Determination from Scales, and Growth of Marked Lake Michigan Lake Trout. By Louella E. Cable. Pp. ii+60. 45 cents. Fishery Bulletin 108: Comparative Study of Food of Bigeye and Yellowfin Tuna in the Central Pacific. By Joseph E. King and Isaac I. Ikehara. Pp. ii+61–68. 30 cents. (Washington, D.C.: Government Printing Office, 1956.) [164

United States Department of the Interior: Fish and Wildlife Service. Statistical Digest No. 36: Fishery Statistics of the United States, 1953. By A. W. Anderson and E. A. Power. Pp. ii+338. 1.50 dollars. Statistical Digest No. 37: Alaska Fishery and Fur-Seal Industries—1954. By Seton H. Thompson. Pp. iv+70. 35 cents. Statistical Digest No. 38: Propagation and Distribution of Food Fishes for the Calendar Years 1953–1954. Prepared by the Branch of Game-Fish and Hatcheries. Pp. ii+37. 20 cents. Circular 39: Wetlands of the United States—Their Extent and Their Value to Waterfowl and other Wildlife. By Samuel P. Shaw and C. Gordon Fredine. Pp. iv+68+21 plates. n.p. Circular 40: This is a Pondfish Hatchery: Rearing and Distributing Warm-water Fish to help maintain Sport Fishing. Pp. 8. 5 cents. Circular 42: This is Cortland—Fish-Cultural Station; Experimental Hatchery; Trout-Nutrition Laboratory; In-Service Training School. Pp. 6. n.p. Circular 44: National Survey of Fishing and Hunting: a Report on the first Nationwide Economic Survey of Sport Fishing and Hunting in the United States, during the calendar year 1955. Pp. ii+50. 40 cents. (Washington, D.C.: Government Printing Office, 1956.) [164

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Carnegie Institution of Washington. Year Book, 1955–1956 (July 1, 1955–June 30, 1956), with Administrative Reports through December 14, 1956. Pp. xi+343+xxx+1 plate. (Washington, D.C.: Carnegie Institution of Washington, 1956.) 1 dollar, paper bound; 1.50 dollars, cloth bound. [234

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University of California Publications in Botany. Vol. 28, No. 5: Morphological Studies on the Kallymeniaceae. By Richard Earl Norris. Pp. 251–334+plates 28–40. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1957.) 1.75 dollars. [234

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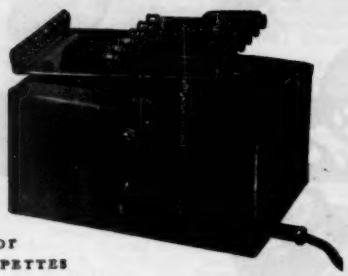

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